# A STUDY ON INFECTED NON UNION TIBIA MANAGED BY ILIZAROV FIXATION

***Dissertation submitted to***

**THE TAMILNADU DR.MGR MEDICAL UNIVERSITY**
**CHENNAI- 600032**

***in partial fulfilment of the regulations***
***for the award of the degree of***

**M.S (ORTHOPAEDIC SURGERY)**

**BRANCH II**


**GOVT. KILPAUK MEDICAL COLLEGE**

**CHENNAI- 600 010**

**APRIL- 2016**

# CERTIFICATE

This is to certify that this dissertation entitled**'A STUDY ON INFECTEDNON UNION TIBIA MANAGED BY ILIZAROV FIXATION'** is a record of bonafide research work done by **Dr.A.KARTHIKEYAN**, post graduate student under my guidance and supervision in fulfilment of regulations of The TamilnaduDr. M.G.R. Medical University for the award of M.S. Degree Branch II (Orthopaedic Surgery) during the academic period from 2013 to 2016, in the Department of Orthopaedics, Govt. Kilpauk Medical College, Kilpauk, Chennai – 600 010.

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# DECLARATION

I **Dr.A.KARTHIKEYAN,** solemnly declare that the dissertation, '**A STUDY ON INFECTED NON UNION TIBIA MANAGED BY ILIZAROV FIXATION**' is a bonafide work done by me in the Department of Orthopaedics, Govt. Kilpauk Medical College, Chennai under the guidance of **Prof. K. Raju, M.S.Ortho., D.Ortho**., Professor of Orthopaedic Surgery, Govt. Kilpauk Medical College, Chennai-600010.

This dissertation is submitted to **"THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY"**, towards partial fulfilment of regulations for the award of **M.S.DEGREE BRANCH II (Orthopaedic Surgery)**.

Place: Chennai Signature

Date: **(Dr.A.KARTHIKEYAN)**

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**CERTIFICATE OF APPROVAL**

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A Study on infected non union tibia managed by ilizarov fixation"- For Project Work submitted by Dr.A.Karthikeyan, Post Graduate in MS (Ortho), Govt. Kilpauk Medical College, Chennai.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

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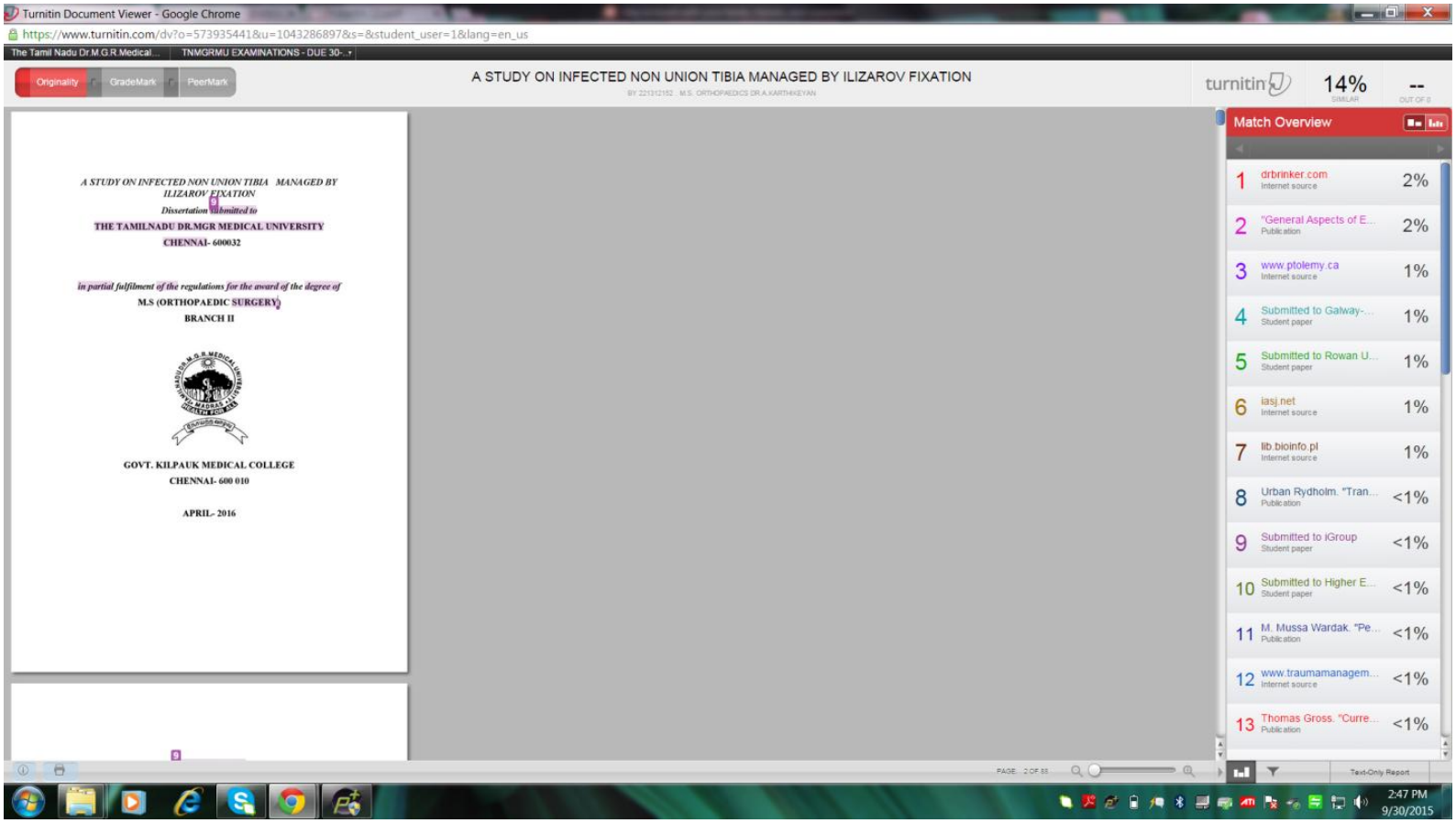
Ethical Committee
Govt. Kilpauk Medical College, Chennai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# CONTENTS

# INTRODUCTION

India has the highest road traffic accident rates in the world .Lower limbs are involved more than 45%. Tibia is more prone to injuries. High energy tibial fractures are associated with compartment syndrome, vascular,neural injuries.Closed fractures have less infection rate than open fractures.

Infected non union of tibia affects functionalability,economic hardship and loss of self esteem to the patient.Infected non-union has been defined as a state of failure of union for 6-8 months with persistent infection at the fractured site [(1)]. Infected tibial non-union is common in clinical practice [(2)] and there are usually some co existingproblems of bone and soft tissue loss,deformities,limb length inequalities and polybacterial infection [(3)]. The treatment of infected tibial non-union has still been a challenge for orthopaedic surgeons [(4)].

A Breakthrough technique invented by Gavriil Abramovich Ilizarov using ring fixator. The stability of the fixation allows weight bearing,ambulation and joint mobilisation.Progressive bone Histiogenenesis following corticotomy and bone transport helps in bring bone gaps eradicating infection and promoting fracture union [(5)]

# AIM AND OBJECTIVES

1. To evaluate cases of infected non-union tibia and their management using ilizarov fixation.

2. To analyse the fracture healing pattern.

3. To analyse the clinical and radiological outcome of the above procedure

# REVIEW OF LITERATURE

## HISTORY:

GAVRIIL ABRAMOVICH ILIZAROV was born in the small town of Beloveghsk in the western part of Whit Russia(1921).

In 1939,he was accepted to the Simpheropol Medical School in Russian region of Crimea. Dr.Ilizarov graduated from the school in 1944.

In 1950, he was promoted to the position of a staff physician in the hospital for the war invalids in small Siberian city of Kurgan, over 2000 km east of Moscow.

The Ilizarov ring was first in the world with two k-wires in crossing direction.He use a careful bone cut with slow gradual traction and almost always there was a new bone formation.

Early 1960, Dr.Ilizarov reported the first successful lengthening of upto 25cm of the shortened lower extremities.

Ilizarov's statements that "in the fire of the distraction regenerate burns the infection".

## SURGICAL ANATOMY

A full knowledge of both anatomy and topography of the leg is essential in planning and operating the lower extremities.

Medial and lateral condyles of the tibia are felt better in a flexed knee.

Tibial tuberosity is the bony prominence in the front of the upper part of tibia, 2.5cm distal to the knee joint line.

Head of the fibula lies posterolaterally at the level of tibial tuberosity.It serves as aguide to common peroneal nerve which winds around the posterolateral aspect of the neck of fibula.

Shin is the subcutaneous anterior border of tibia. It is sinuosly curved and extends from the tibial tuberosity to anterior margin of the medial malleolus.

Medial surface of the tibia is subcutaneous except in the uppermost part.

Medial malleoli is the bony prominence on the medial side of the ankle. It is formed by a downward projection from the medial surface of the lower end of tibia.

Lateral malleolus is a bony prominence on the lateral side of ankle. It is formed by the lower end of the fibula. It is larger but narrower than the medial malleolus.The posterior borders of two malleoli are in the same coronal plane, but the anterior border of lateral malleolus is about 1.5cm behind that of medial malleolus.

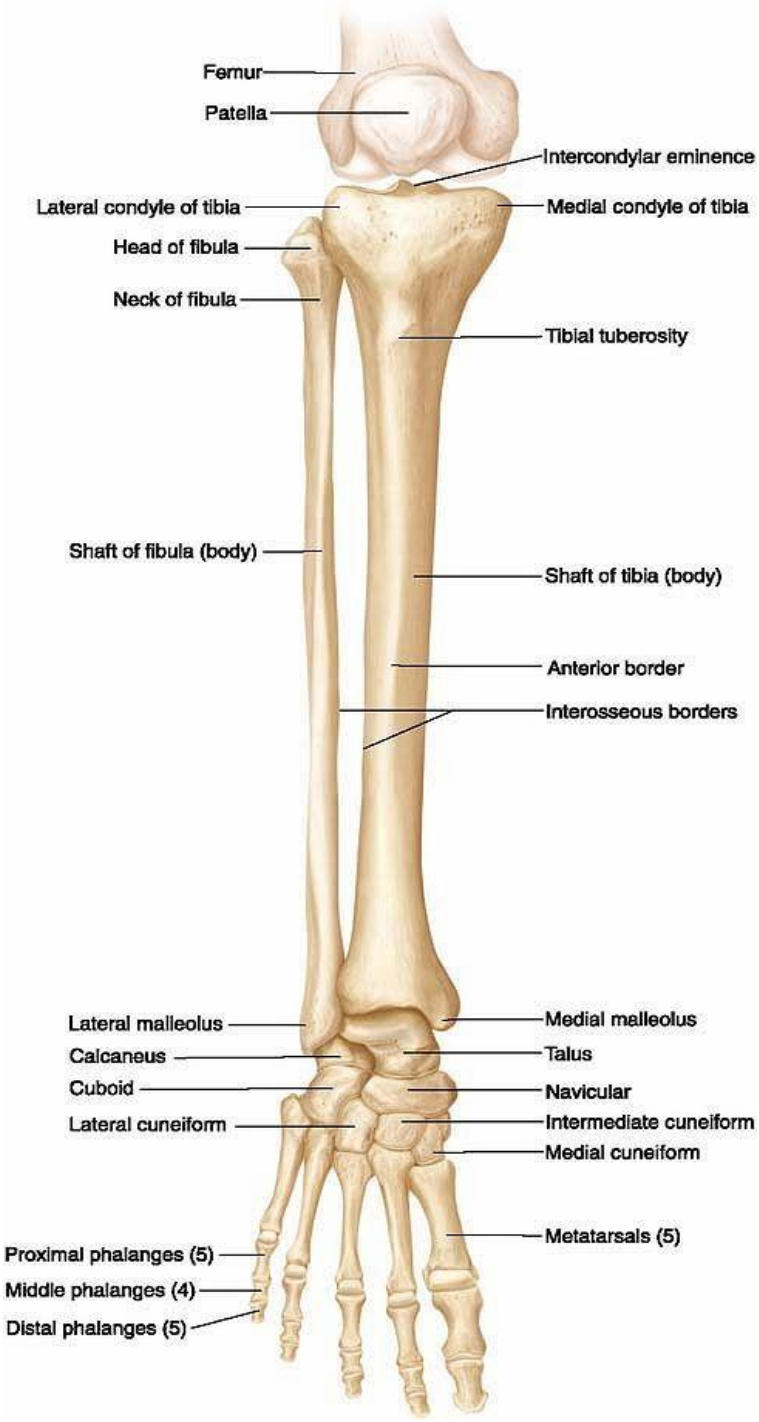
Gastrocnemius and the underlying soleus forms the flesh prominence of the calf. These muscles become prominent when heel is raised as standing on toes.

Tendocalcaneus is the strong, thick tendon of these muscles, it is attached below the posterior surface of calcaneus.

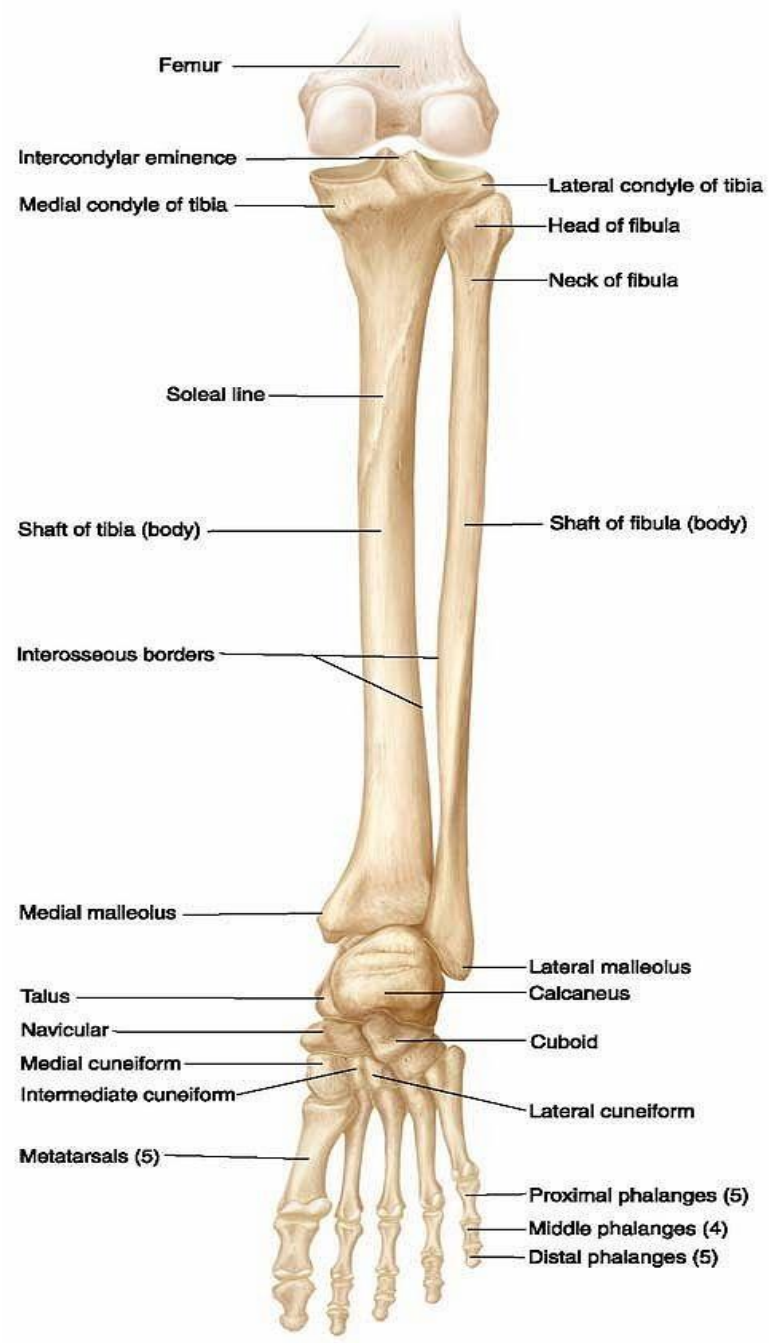
**ANTERIOR COMPARTMENT**

The muscles of the anterior compartment of the leg are tibialis anterior,extensor halluces longus, extensor digitorum longus, extensor digitorum brevis, peroneus tertius. Deep peroneal nerve is the nerve of anterior compartment of the leg. This is one of the two terminal branches of common peroneal nerve.

# ANTERIOR VIEW OF TIBIA AND FIBULA



# POSTERIOR VIEW OF TIBIA AND FIBULA



## LATERAL OR PERONEAL COMPARTMENT

Lateral compartment of the leg is bounded anteriorly by the anterior intermuscular septum, posteriorly by the posterior intermuscular septum, medially by the lateral surface of fibula and laterally by the deep fascia. The muscles of the compartment are peroneus longus and brevis. Superficial peroneal nerve is the nerve of lateral compartment.

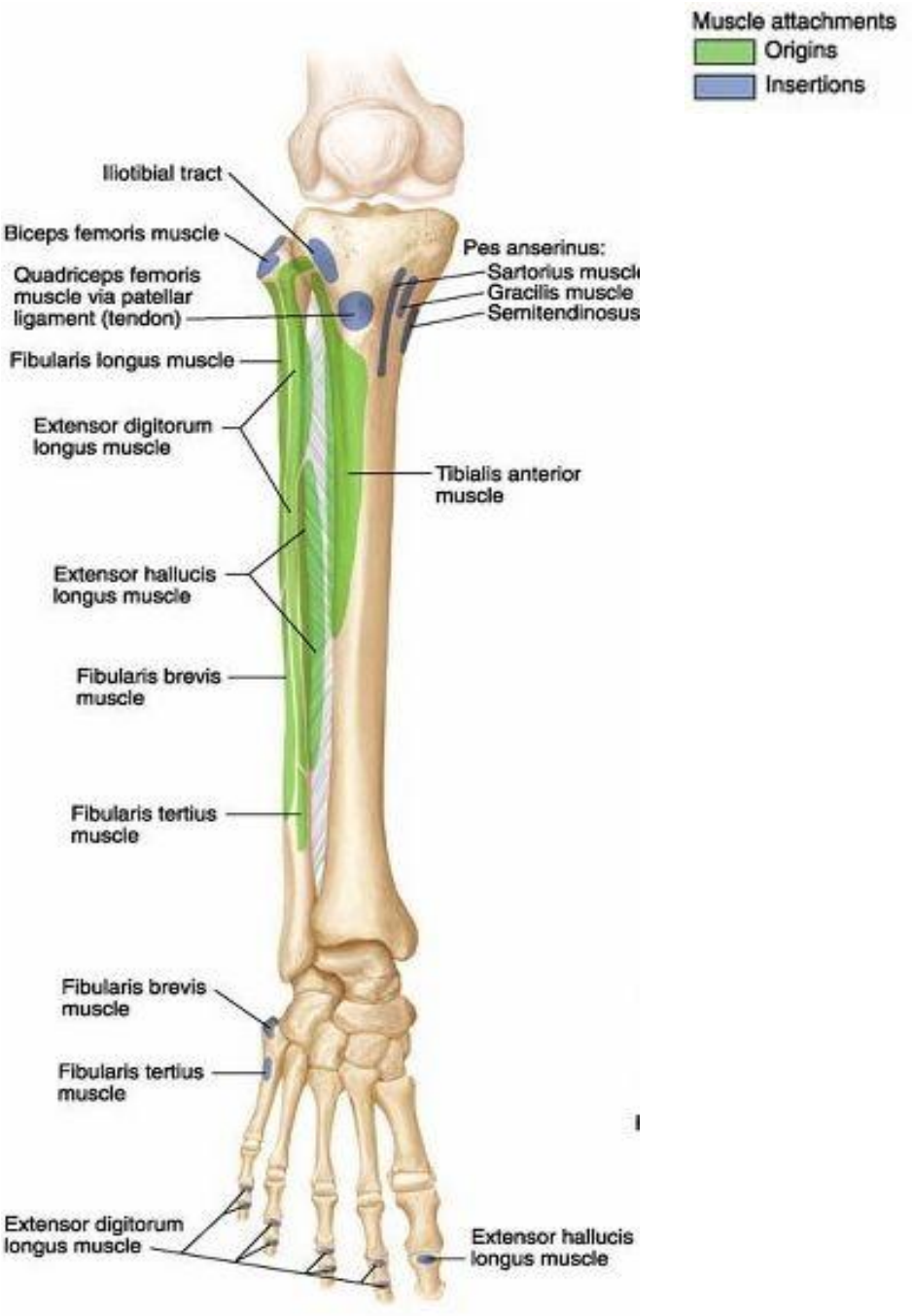
## SUPERFICIAL POSTERIOR COMPARTMENT

Gastrocnemius, Soleus and plantaris are in the superficial posteriorcompartment. Plantar flexion of the foot is the function of this compartment.

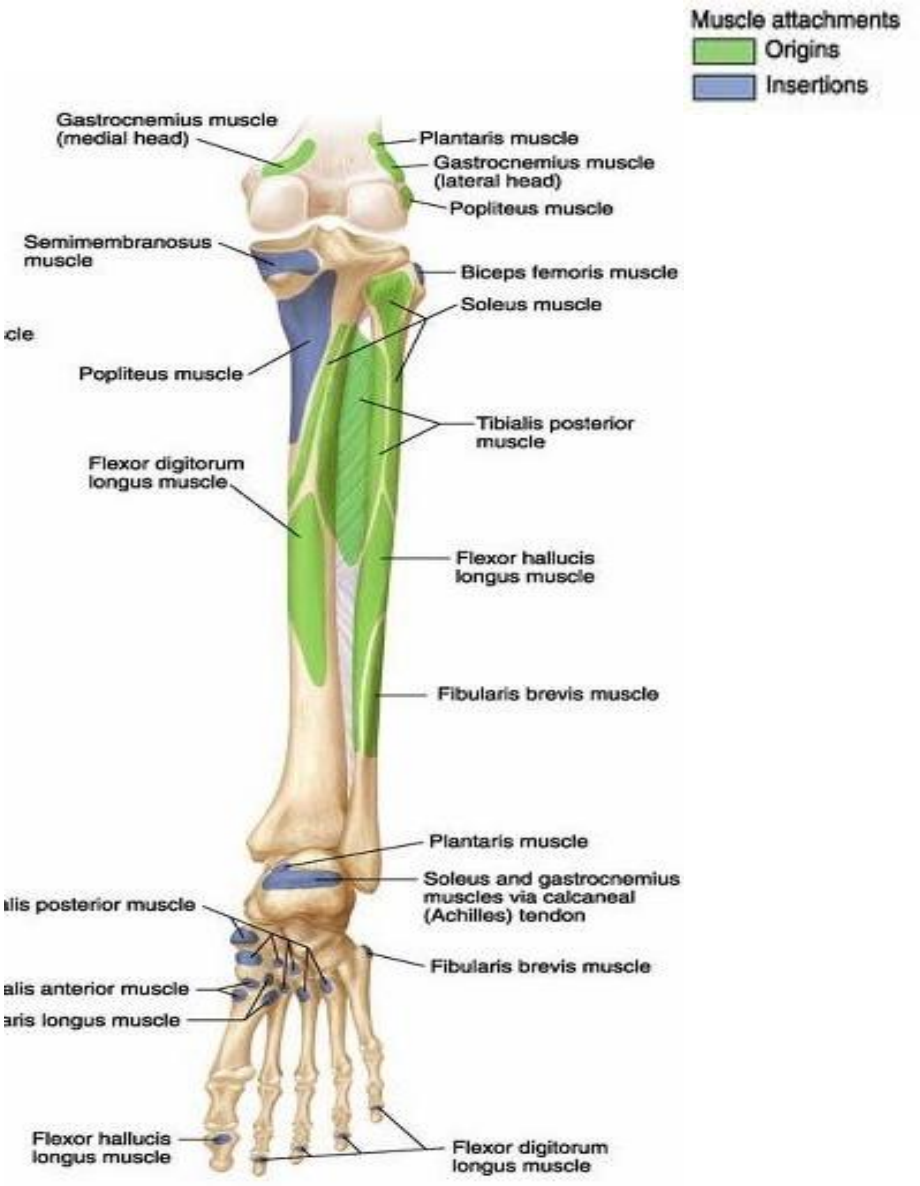
## DEEP POSTERIOR COMPARTMENT

Deep posterior compartment contains Tibialis posterior, Flexor hallucis longus, Flexor digitorum longus and popliteus. Plantar flexion of foot and toes and inversion of foot are the main functions. Posterior tibial artery is the main arterial supply.

# ANTERIOR MUSCLE ATTACHMENT



# POSTERIOR MUSCLE ATTACHMENT



**BLOOD SUPPLY: (6)**

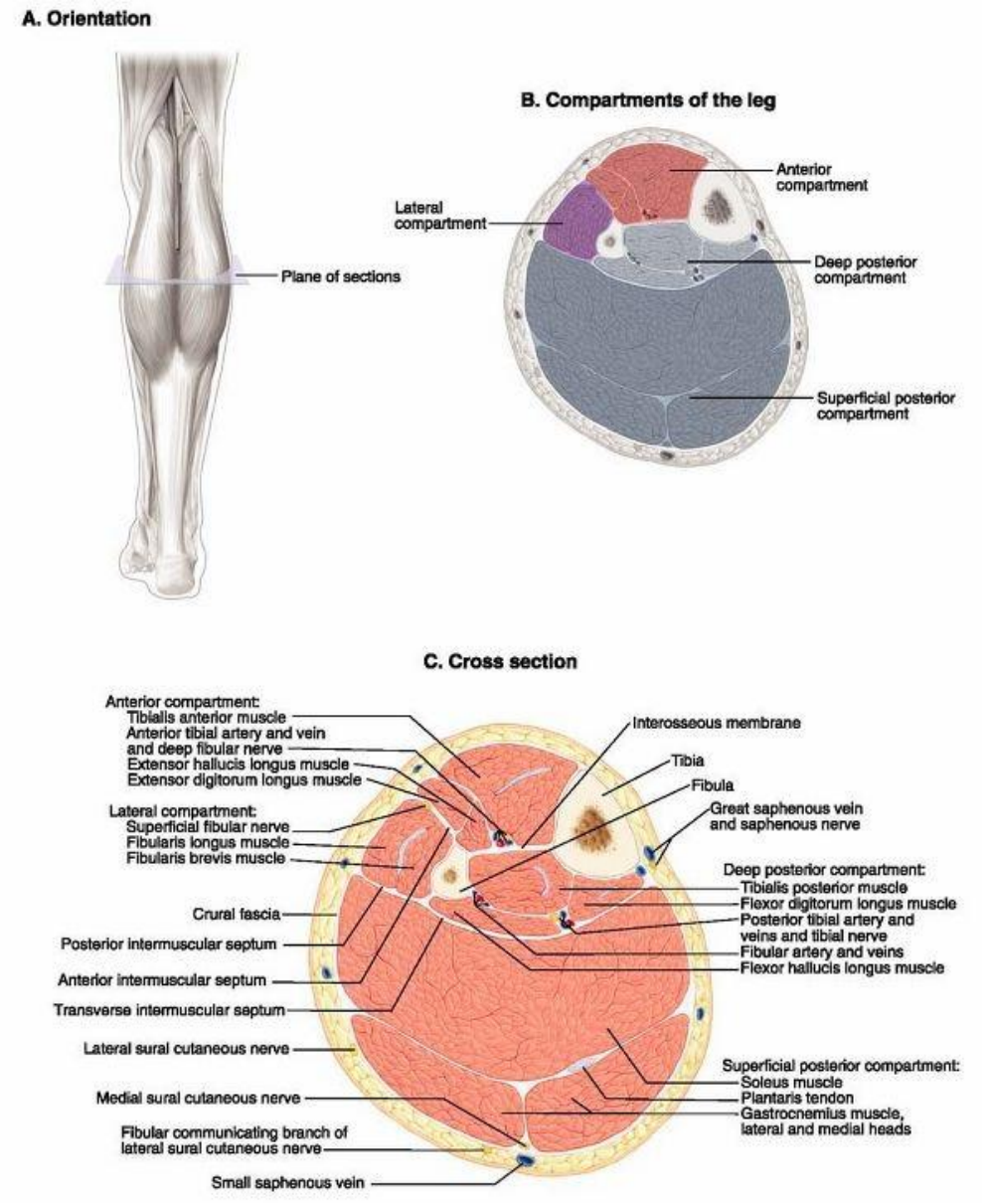
1. Principle nutrient artery is the largest nutrient artery in the body. It is a branch of the posterior tibial artery which enters the bone on its posterior surface at the upper end of vertical ridge. Dividing into three ascending and one descending branch which gives off branches to endosteal surface.

2. The periosteum receives its blood supply from the anterior tibial artery. Periosteal arterioles enters through diaphyseal cortex.

3. Metaphyses are supplied by metaphyseal arteries.

4. Epiphyses are supplied by epiphyseal arteries.

The lower third of tibia is more prone for infection and non-union because of decreased blood supply and inadequate muscle cover.


A. Orientation
Plane of sections
B. Compartments of the leg
Anterior compartment
Lateral compartment
Deep posterior compartment
Superficial posterior compartment
C. Cross section
Anterior compartment:
Tibialis anterior muscle
Anterior tibial artery and vein
and deep fibular nerve
Extensor hallucis longus muscle
Extensor digitorum longus muscle
Lateral compartment:
Superficial fibular nerve
Fibularis longus muscle
Fibularis brevis muscle
Crural fascia
Posterior intermuscular septum
Anterior intermuscular septum
Transverse intermuscular septum
Lateral sural cutaneous nerve
Medial sural cutaneous nerve
Fibular communicating branch of
lateral sural cutaneous nerve
Small saphenous vein
Interosseous membrane
Tibia
Fibula
Great saphenous vein
and saphenous nerve
Deep posterior compartment:
Tibialis posterior muscle
Flexor digitorum longus muscle
Posterior tibial artery and
veins and tibial nerve
Fibular artery and veins
Flexor hallucis longus muscle
Superficial posterior compartment:
Soleus muscle
Plantaris tendon
Gastrocnemius muscle,
lateral and medial heads

## BRINKAR DEFINITION OF NON-UNION

A fracture is said to have “gone on to nonunion” when the normal biologic healing processes cease to the extent that solid healing will not occur without further treatment intervention. The definition is subjective, with criteria that result in high interobserver variability. The literature reveals a myriad of definitions of nonunion.

Food and Drug Administration (FDA) defines a non-union as a fracture that is at least 9 months old and has not shown any signs of healing for 3 consecutive months.[7,8] Müller’s[9] definition is failure of a (tibia) fracture to unite after 8 months of nonoperative treatment. These two definitions are widely utilized, but their arbitrary use of a temporal limit is flawed.[10] For example, several months of observation should not be required to declare a tibial shaft fracture with 10 cm of segmental bone loss a nonunion. Conversely, how does one define a fracture that continues to consolidate but requires 12 months to heal?[11]

We define nonunion as a fracture that, in the opinion of the treating physician, has no possibility of healing without further intervention. We define delayed union as a fracture that, in the opinion of the treating physician, shows slower progression to healing than anticipated and is at risk of nonunion without further intervention. To understand the

biological processes and clinical implications of fracture nonunion, an understanding of the normal fracture healing process is required. The following section reviews the local biology of fracture healing, requirements for fracture union, and types of normal fracture repair.

## PARAMETERS FOR INFECTED NONUNION OF TIBIAL FRACTURE: [12]

Exposed bone that has no vascularised coverage for more than 6 weeks.

1. Purulent drainage.
2. Positive bacterial culture from the wound.
3. Histological evidence of necrotic bone contains empty lacunae.

Patient's history and physical examination is must for infected non-union of tibia. An history of open fracture associated with pain and movement at fracture site in the presence of soft tissue swelling and previous surgery, all these suggest infection even in the absence of active drainage, systemic symptoms or elevated laboratory parameters.

**CAUSES: [13]**

Infected non-union of tibia can develop:

a) After an open fracture
b) After a previous open reduction and internal fixation (ORIF)
c) Sequale of chronic hematogenous osteomyelitis.

The most common cause of infected non-union is open fracture. Tibia is most commonly involved.[14]

**PATHOPHYSIOLOGY OF POSTTRAUMATIC OSTEOMYELITIS: [15,16,17]**

Osteomyelitis is a most common complication of open fractures and associated with severe soft tissue injury. Even after years of quiescence, osteomyelitis has tendency to recur. It has been proposed that cure is not an appropriate word to osteomyelitis, that the best can hope to accomplish is arrest.

The stages are:

a. Entry of pathogens
b. Establishment of infection
c. Interference in host reaction to infection

d. Damage to the host

e. Persistence of infection

a)Entry of pathogens:

Skin and mucus membranes are mechanical barriers that normally protect the host. Osteomyelitis is an infrequent complication in closed fractures. The incidence of osteomyelitis is much higher in open fractures. From the environment bacteria have the opportunity to enter the wound directly.

Farm injuries – Clostridium perferinges, fresh water injuries – Aeromonas hydrophilia, pseudomonas aueroginosa and salt water injuries – Vibrio, Erysipelothria infections are common contamination. Most common post traumatic osteomyelitis are caused by hospital acquired pathogens such as coagulase positive staphylococci, enteric Gram negative bacilli and pseudomonas aueroginosa.

b) Establishment of infection:

The bacteria in a wound is not sufficient to cause infection. Approximately 60% to 70% of open fractures are contaminated by bacteria.

Factors involved in establishment of infection are:

1. Damage to the soft tissue and bone – there is 30 – 40% risk of infection in type 3B open fractures. Damaged soft tissue and bone express potential binding sites for bacteria such as collagen.
2. Blood supply are compromised – necrosed tissue act as foreign body.
3. Implant used for stabilization – more foci for colonization of bacteria.

Bacteria attached to host surface are ability to produce biofilm (protective covering over bacteria under which colonies thrive). Biofilm forms strong bond with glycoproteins of the tissue substrate. Biofilm protects bacteria from antibiotics, inhibits phagocytosis and impairs T lymphocytes and b lymphocytes function.

c) Interference in host reaction to infection:

Acute inflammatory reaction is the initial host response to infection which fights against the bacteria. Trauma has been reported to delay the inflammatory response, depress cell mediated immunity, function of

polymorphonuclear leukocytes including chemotaxis, superoxide production and microbial killing.

The prosthetic implant inside the body at the site of infection can inhibit the efforts of host defence mechanisms.

Dean et al found that Cr and Ti inhibit mitogen stimulated T cell and B cell proliferation, production of IL-2 and INF gamma.

d) Damage to host:

The primary role of initial inflammatory response is to destroy bacteria and control the spread of infection. Proteolytic enzymes released by phagocytes also can damage the surrounding tissue.

Osteopenia may predispose the patient to pathologic fractures. If a fracture is present, bone resorption prevent or delay its healing.

Bacterial products lipopolysaccharide of Gram negative bacteria and surface associated protein of Staph.aureus are stimulators of bone resorption.

The most important mediators of bone resorption are proinflammatory cytokines – IL-1 beta, IL-6 and INF alpha released in

acute inflammatory response to injury and infection. Systemic infection may cause osteomyelitis but are not common.

e)Persistence of infection:

Local tissue damage, fracture instability, deranged host immune system, formation of biofilm and bacteria with surface adherence.

**NON UNION RELATED TO HOST FACTORS**

Host factors play an important role in fracture healing

1. Smoking
2. Diabetes
3. Other factors

**1.SMOKING**

Cigarette smoking is an important factor to cause delayed union and non-union. Exposure to second hand smoke and history of previous smoking has been shown to delay bone healing.smoking increases the risk of infection and osteomyelitis. Persistent infection, non-union, amputation like complications are three times higher in the smokers compared with the non-smokers. Smoking reduces the periosteal bone morphogenetic protein (BMP) gene expression.

## 2.DIABETES

Diabetes decreases the cellular proliferation. Diabetes decreases the callus strength. Uncontrolled diabetes increases the risk for delayed union and non-union. Diabetes also increases the risk of infection and decreases the soft tissue healing. Haemoglobin A1c greater than 7% were significantly associated with bone healing complications.

## 3.OTHER FACTORS

- NSAID’s found to increase the risk of non-union (odds ratio 3)
- Irradiated bone or bone with tumor are high risk for delayed or non union
- Long term use of bisphosphonates can lead to impaired healing and stress farcture.

## INVESTIGATIONS

1. Hematologic investigation
2. Radiographic investigation
3. Bone scan
4. Tissue biopsy

1.Hematologic investigation:

A raising leukocyte level or Westegren erythrocyte sedimentation rate can be consistent with ongoing deep bony infection,they are not necessarily diagnostic [18]. Normal level may seen even in active discharge. Evaluation of glucose tolerance, renal function and liver function should be considered before beginning operative reconstruction.

2.Radiographic investigation:

Cortical irregularity,periosteal reaction, alteration in normal mineralization,presence of a bony sequestrum, presence of an ununited fracture and association with previously implanted metal internal fixation devices.[19]

3.Bone scan:

The triple phase technetium 99 MDP bone scan (Methyl diphosphate) can help to distinguish an inflammatory condition from a deep bony infection [20]

The 67-Gallium citrate isotope can accumulate at the site of infection or inflammation, an increase in the permeability of the local vascular structure and microorganism. 67-gallium scan must be

substantially greater in uptake than the technetium 99 MDP. Then the bone scan is suggestive of deep bony infection.

Another diagnostic test is labelled leukocytes with 111-inidium. Inidium was compared with technetium and gallium scans, the overall sensitivity rate 83%,with a specificity rate of 86% and an accuracy rate of 83%.

4.Tissue biopsy:

This is the most convenient and accurate method to identify ongoing deep bony infection.

**CLASSIFICATION OF INFECTED NONUNION TIBIA**

1. Weiland's [21](on extent of infection)-

Type 1- Bone exposed and soft tissue infection present.

Type 2- Circumferential cortical & endosteal infection present.

Type 3- - Circumferential cortical & endosteal infection with segmental bone loss present.

2. Gordon & Chiu's (on severity of underlying bone damage.) [22]

A- Tibial defect & nonunion without substantial bone loss (< 3cm)

B- Tibial defect >3cm with intact fibula

C- Tibial defect >3cm with nonunion fibula

3.University of Texas classification-(location of infection and immune competence of the host)

1- Intramedullary
2- Superficial
3- Local
4- Diffuse with segmental bone loss.

Host immune system

Type A- Healthy with adequate soft tissue cover;

Type B- With local or systemic compromise;

Type C-Severely compromised, contraindicated for surgical reconstruction.

4. May et al [12] -

Type 1 - An intact tibia & fibula that can withstand functional loads.The skeletal involvement is unicortical & debridement can be done without any threat to skeletal integrity.

Type 2 - An intact tibia with bone graft needed for structural support.

Type 3 - A tibial defect </= 6cm with intact ipsilateral fibula.

Type 4 - A tibial defect > 6cm with intact ipsilateral fibula. (The defect > 6cm can not be bridged successfully by autograft alone)

Type 5 - A tibial defect > 6cm & no usable fibula.

5 Dror Paley-

A1- Mobile atrophic, Bone loss <1cm ,

A2- A2.1- Stiff hypertrophic without deformity, bone loss <1cm

A2.2- Stiff hypertrophic with deformity, bone loss <1cm

B1- Osseous defect >1cm, length maintained

B2- Bone loss >1cm, shortening present

B3- Both osseous defect & bone loss with shortening.

5. Jain et al [13]

Type A - Infected nonunion of long bones with nondraining (quiescent) infection, with or without implant in situ.

Type B - Infected nonunion of long bones with draining (active) infection. Both are classified further into two subtypes: 1) nonunion with a bone gap smaller than 4 cm or 2) nonunion witha bone gap larger than 4 cm.

**TREATMENT BASED ON CLASSIFICATION**

Accoring to Jain et al [13] -

Type A1 - (Quiescent infection with bone defect less than 4cm)- Single-Stage debridement and bone grafting with fracturestabilization are the methods of choice.

Type B1 - (Draining infection with bone defect less than 4cm)- Adequate debridement, fracture stabilization, and second- stage bone grafting gives desirable results

Type A2 - (Quiescent with bone defect > 4cm) and

Type B2 - (Draining infection with bone defect > 4cm)– Debridement And Distraction histiogenesis is preferred.

**According to Dror Paley's classification- (Modified by Maurizio Catagni Classification.** [23]

| CLASSIFICATION | PATHOLOGY | TREATMENT |
|---|---|---|
| A1 | Mobile atrophic non-union with bone loss less than 1 cm | Excision of the atrophic ends and bifocal osteosynthesis |
| A2.1 | Stiff hypertrophic without deformity and bone loss less than 1 cm | Monofocal osteosynthesis |
| A2.2 | Stiff hypertrophic without deformity and bone loss less than 1 cm | Monofocal osteosynthesis and correction of deformity |
| B1 | Osseous defect more than 1 cm with length maintained | |
| B1.1 | Defect 1cm to 5 cm | Bifocal osteosynthesis |

| | | |
|---|---|---|
| B1.2 | Defect more than 5cm | Trifocal osteosynthesis |
| B1.3 | Defect more than 8-10 cm | Trifocal osteosynthesis and transport using cromed longitudinal olive wire |
| B2 | Bone loss more than 1cm with shortening | |
| B2.1 | Shortening less than 5cm | Bifocal osteosynthesis of tibia with fibular osteotomy |
| B2.2 | Shortening more than 5cm | Trifocal osteosynthesis with fibular osteotomy |
| B3 | Both osseous defect and bone loss with shortening | Bone transport is done till non-union site is docked and than lengthening continued in order to eliminate shortening |

## COMPONENTS AND INSTRUMENTS OF ILIZAROV APPARATUS

The ilizarov fixator is a device which works as a compression and distraction apparatus. The frame of the fixator can be assembled in almost any unlimited number of variations and combinations depending on the task at hand. It is of no surprise that this system has been called as ‘’HUMAN ERECTOR’’

DROR PALEY

The ilizarov apparatus has two types of components:

a. Primary component:

Standard parts that connect the skeleton to the frame such as transosseus wires,rings and wire fixation bolts.

b. Secondary components:

Parts used to construct the frame of the apparatus such as threaded rods, telescopic rods,connecting plates,hinges,posts,nuts,bolts and various wrenches.

**EQUIPMENTS REQUIRED**

1. Rings
2. Connecting Bolts
3. Nuts
4. Rods
5. Connecting plates
6. Threaded socket and bushing
7. Supports,Posts and Half Hinges
8. Wire fixation bolts
9. Wire fixation buckles

10. Washers
11. Wrenches
12. Wires
13. Wire tensioner

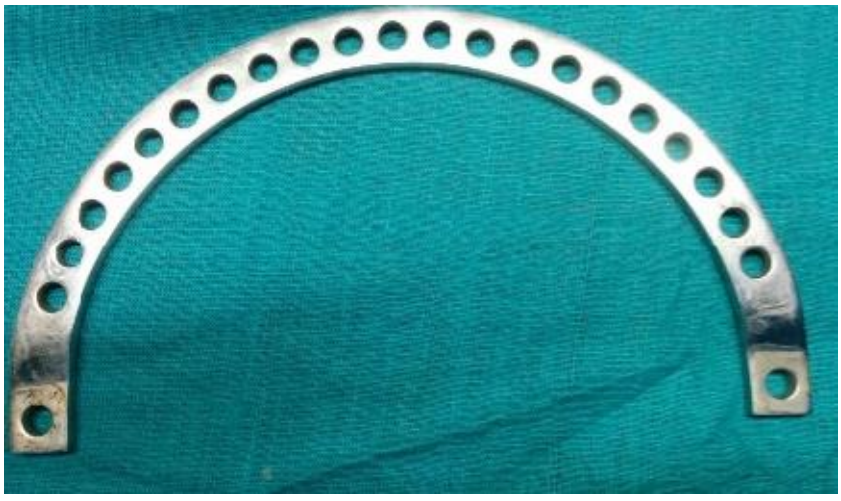
Ring: [24]

The ilizarov ring has three main functions:

1. Supports k wires and half pins

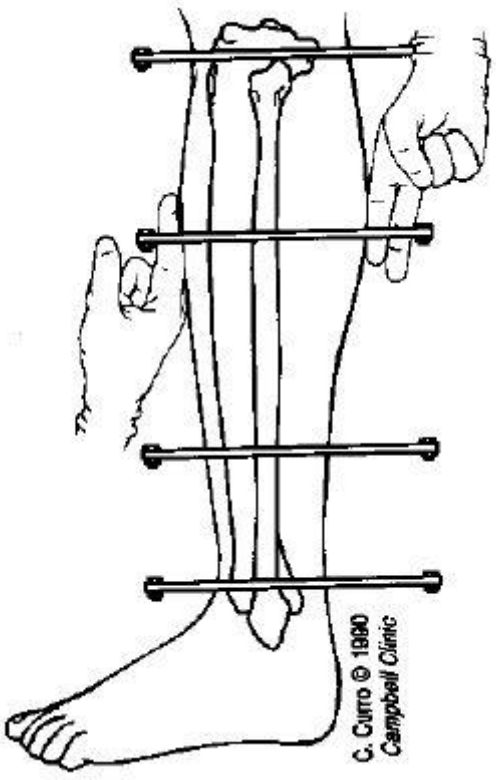
2. Two or more rings connected to form a frame of the apparatus

3. Bear supplementary parts of the frame necessary for dynamic bone treatment

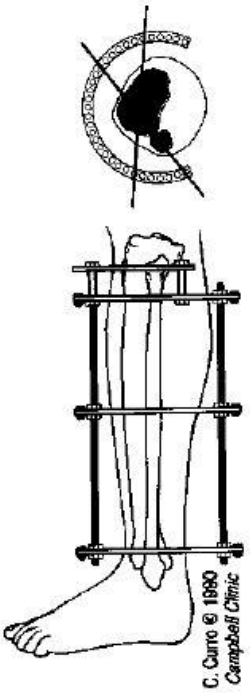


**HALF RING**

Frame size is selected to allow 2 to 3 cms clearance between inner edges of rings and skin [25]. Stainless steel half rings are available in 80,100,110,120,130,140,150,160,180,200,220 and 240mm inner diameters. Stainless steel rings are available in 130,150,160 and 180mm inner diameters.omega rings in stainless steel have 120,130 and 150mm inner diameters.




Two to three cm clearance typical tibial mounting with frame.

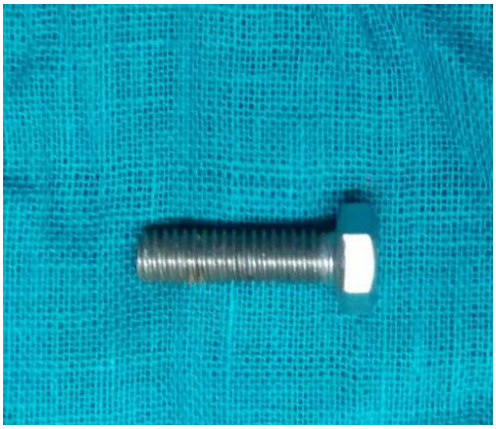



Utilizing a 5/8 ring to allow full knee flexion

Connecting bolts:

There are three types of connecting bolts in a set. Common features are the threaded legs 6mm in diameter with a pitch equal to 1mm between each thread and a standard 10mm hexagonal head, 4mm thick. The bolts differ from each other in length, being 10,16 and 30mm. [26]

**BOLT**



Nuts:

The smallest component of the set in a 10mm nut, which serves multiple purposes in the frame assembly. It is used to:

a. Stabilize the connecting rod
b. Tighten the connecting bolts
c. Tighten the wire fixation bolt
d. Act as driven force for the ring in a distraction-compression movement
e. Lock the socket and/or bushing onto a threaded rod
f. Affix the pulling wire of a distraction device
g. Achieve fixed positioning of a male support
h. Secure hinge clearance
i. Secure a gap on the threaded rod

There are three types of hexagonal 10mm nuts, a full or 6mm nut, a three quarter or 5mm nut and a half or 3mm nut.

**NUT**

Rods :

The main type of connector in the ilizarov system is the 6mm diameter stainless steel threaded rod. The threaded rods come in 10 lengths, 60,80,100,120,150,200,250,300,350 and 400mm.

All rods share the same pitch which equals 1mm. This is important because it signifies that one full turn of the lock nut corresponds to a change also equal to 1 mm.

The graduated telescopic rod is an invention of ASAMI-Italy. This graduated telescopic rod system locks after the surgeon turns the device one-quarter turn,which corresponds to one-fourth of desired distraction or compression. To turn the device beyond 0.25mm, the safety level must be released.

**ROD**

Connecting plates :

Are used in

1) The ilizarov apparatus to be reinforced on either a temporary or permanent basis.
2) In the assemblage of the oval ring for the foot component; for large frames and deformity correction.
3) To connect two or more components on different planes.

5 types of connection plates

1) Short connection plates
2) Long connection plates
3) Connection plate with threaded end
4) Twisted connection plate
5) Curved connection plate

Threaded sockets and bushing :

The threaded rods can be reinforced and lengthened by adding two types of connection, a threaded socket and a bushing. Both of these components can serve many purposes, but they mainly function as axillary connectors between two rods. Both of these parts are cylindrical

with a hollow vertical canal, and both have a perpendicular, threaded hole running through the centre from side to side. But they differ in other features and chiefly their function in the frame.

The bushing is a short cylinder with a smooth, unthreaded apertus running through it. A perpendiculathreaded hole dissects the centre of the bushing, which serves different purposes but is particularly useful for the attachment of additional frame components.

**THREADED SOCKET**

**SUPPORTS, POSTS AND HALF HINGES**

Supports, posts and half hinges are axillary parts of great importance because they facilitate a variety of frame construction . Their advantages

i) They can be placed virtually at any location

ii) They can be turned 360 degrees around their axis

iii) They can be fixed in any desirable position. They also serve as an additional reinforcement for many components.

MALE SUPPORT

MALE HALF-HINGE

FEMALE SUPPORT

## WIRE FIXATION BOLTS

Two types of bolts are used, the cannulated wire fixation bolts and slottedwire fixation bolts. Both types of wire fixation bolt permit introduction of a K-wire into a hole or slot and also the fixation of a k-wire between the ring wall and the bolt head.

**WIRE FIXATION BOLT**

## WIRE FIXATION BUCKLES

Their principal advantage in that they can be used in ring locations where there are no accessible holes. For example, they may be placed over the junction of two half-rings or between two holes.

**WASHERS**

Six types of washers are

1) The 1.5mm thick, 12mm diameter washer with two flat surfaces. The diameter of the washer is equal to that of the nut and the bolt-head, enabling its use on ring holes situated next to each other.

2) The 2mm thick, 14-mm diameter washer with two flat surfaces. This washer is used mostly with the wire fixation bolts and for support-port pairs adjustment.

3) The 2-mm thick, 20 mm diameter washer with two flat surfaces. This washer is used only for adjustment of a threaded rod to the femoral arch

4) The 3-mm thick, 14-mm diameter washer with one flat and one slotted surface. After this washer is used to adjust the wire-fixation bolt to the plane of an introduced k-wire.

5) The 4-mm thick, 14mm diameter washer with one flat surface and one slotted surface.

6) The 3-mm thick, 12mm diameter conical washer-couple. This washer has a particular purpose, which is to adjust parts positioned in an angulation of up to 15 degrees.

**WASHERS**

**WRENCHES**

They are important for tightening nut and bolt. It is important to emphasize that tightening always must be performed simultaneously with two wrenches. One wrench is attached to a motionless part and the second is attached to the part being tightened.


**WRENCHES**

**WIRES**

a) 1.5mm trochar – pointed wire

b) 1.5mm bayonet – pointed wire

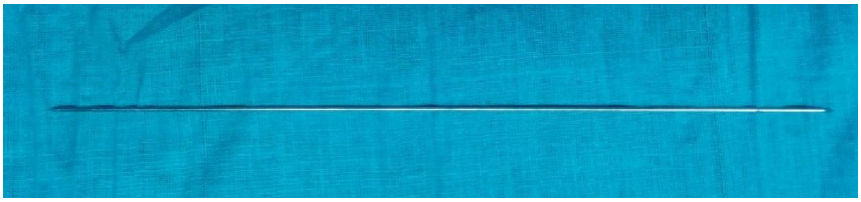
c) 1.8mm trochar – pointed wire

d) 1.8mm bayonet – pointed wire

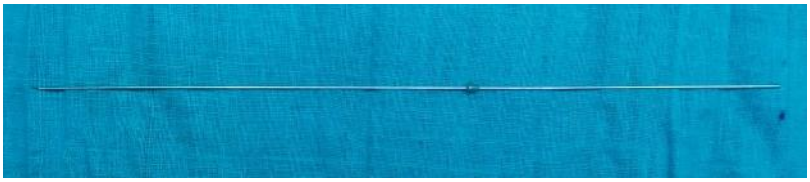
e) 1.5mm olive (stopper) wire

f) 1.8mm olive wire

The bayonet point wire used in diaphyseal cortex, the trocar point used in primarily cancellous bone. Olive (stopper) wire is mainly used for interfragmentary compression.



**K-WIRE**



**K-WIRE WITH STOPPER**

**WIRE TENSIONER**

The quality of bone healing and(or) bone regenerate development depends on the strength of wire tension.

The range of the wire tensioning strength in 50 to 130 kg

1) Wire on half ring: 50 to 70 kg
2) Drop wire, depending on the size of the supporting posts: 50 to 80 kg
3) Single wire on a ring: upto 100 kg
4) Two or three wires on a ring in a young patient: 110 kg for each wire
5) Two or three wires on a ring in an adult patient: 120 to 130 kg for each wire.
6) Wire with an olive stopper: 100 to 110 kg
7) Wire with olive stoppers used for interfragmentary compression, depending on bone condition: 50 kg

**WIRE TENSIONER**

## OTHER COMPONENTS

Half pins, half pin fixation bolts and rancho cubes are other components in ilizarov system.

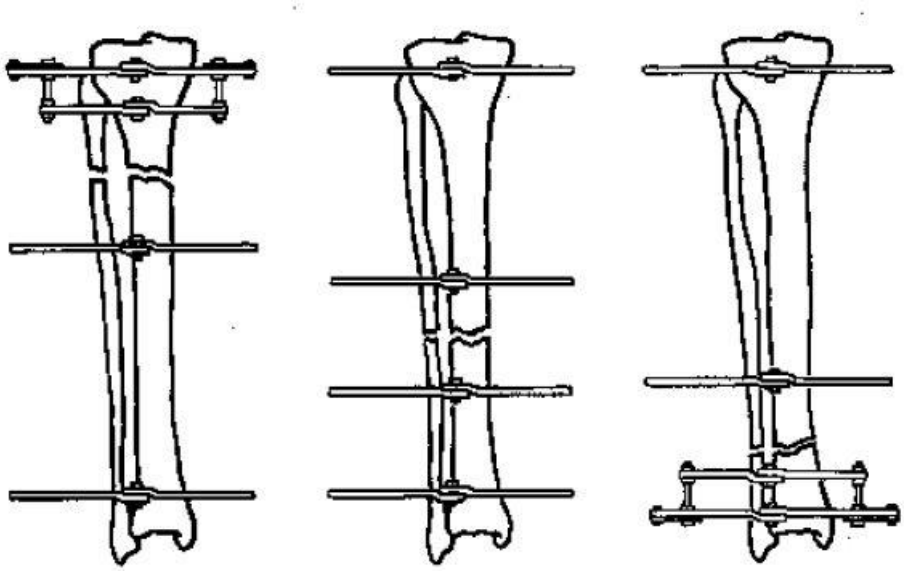
## BIOMECHANICS OF THE ILIZAROV EXTERNAL FIXATOR

The frame connected to the bone, the resultant frame of fixator replicates the cylindrical shape of the tubular cortical bone shell, with greater diameter. This design allows the fixator frame to accommodate high axial, torsion and compression loading.

With the fixator in place, the mechanical action of compression or distraction can be performed in many different directions; in any position fixator maintains proper bone fragment stability, important for achievement of tissue growth and regeneration.

The number of the rings is the most important factor for the frame stability increased number brings about more stable construction. The optimal number of rings for lower extremity is four. The rings have to be allocated by two to each bony segment above and below fracture or non-union. Biomechanical principles have shown that, for the strength and stiffness of frame, the distance between two neighbouring rings must be not greater that of the diameter of the ring.

It is preferable that the rings of the frame are of the same size. As a rule, k-wire span must be atleast 3cm to prevent possible ring pressure in case of the soft tissue swelling.



**RING PLACEMENT RELATIONSHIP TO FACTURE LOCATIONS**

## BIOMECHANICS OF THE ILIZAROV METHOD

Professor ilizarov coined for this a law a term “tension-stress effect” and formulated it thus: “slow, steady traction of tissues caused them to become metabolically activated resulting in an increase in the proliferative and biosynthetic function”

Ilizarov was the first to observe that under the influence of forces of particular rate and frequency the motion of distraction produces effect of neogenesis and growth of virtually all the local tissues involved: bone,

muscles, tendons, fascia, vessel's walls, nerve's intercalary growth of existing trunks and growth of new nerve fibres and the skin.

The second important biologic law: the shape forming processes acting upon bone tissue are dependent upon the magnitude of the applied load and adequacy of blood supply.

The basic function of the ilizarov fixator is to hold the bony fragments in alignment, while allowing axial dynamization at the fracture site.

Goodship[27], demonstrated that induced axial micromotion at the fracture site can accelerate fracture healing.

Biomechanics of ilizarov fixator has been extensively studied clinically and experimentally by G.A.Ilizarov, B.Flemming, Dror Paley, M.Pope[28] and many others.

## THE ILIZAROV CORTICOTOMY[29]

The surgical methods of limb lengthening date back to codivilla's first report in 1903 [30] numerous configurations of osteotomies have been tried. These include step-cut, oblique, spiral and transverse [30,31,32,33]. A

spiral osteotomy offers even greater cortical apposition and surface area (34,35).

It is important not to transect the periosteum transversely and if possible to close the sleeve of the periosteum after the osteotomy is performed.(36)

It remains a mystery as to when exactly the term corticotomy first came into published use by ilizarov. The first published use by ilizarov of the word corticotomy this author could locate was in 1982(37) in one of the internal publications of ilizarov's institute.

The word compactotomy has been used to describe metaphyseal level corticotomies; corticotomy is reserved for diaphyseal level corticotomies.(38)

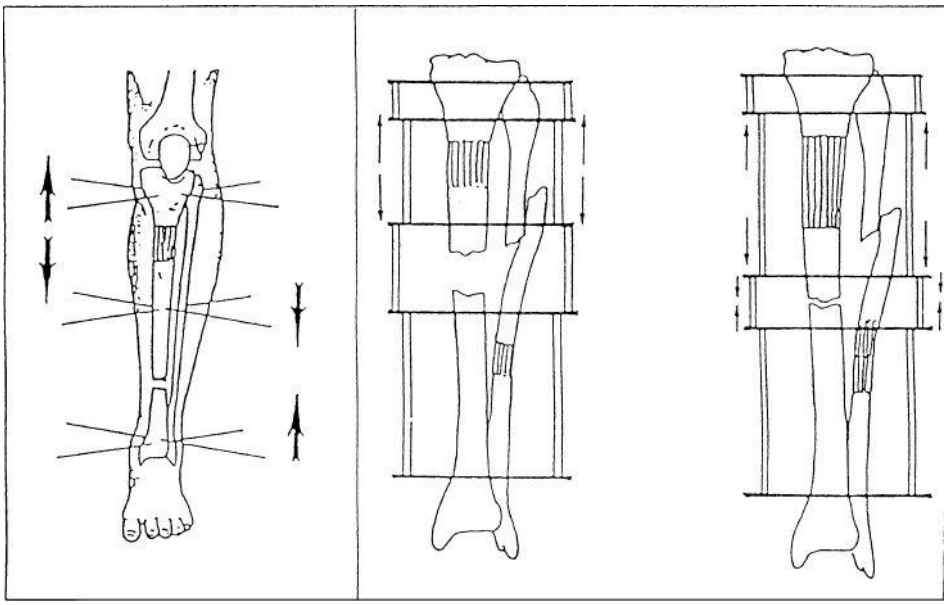
The timing of onset of distraction (latency period) (39,40). The conclusion from these studies is that a latency before distraction of approximately 1 week is beneficial to the new bone formation. Similarly a rate of distraction of atleast 4 times per day also optimize the situation.

## DISTRACTION OSTEOGENESIS

The regenerative processes depends upon two main factors- the adequacy of the local blood supply and the stimulating effect of microvibration of the tensioned k wires. Quality and quantity of the newly formed bone depends upon several factors

- The rigidity of the bone fragment fixation
- The degree of damage of the bone marrow , the periosteal, soft tissues and the nutrient blood vessels at the level of osteotomy
- The speed of distraction (rate)
- The distribution of forces on the bone circumference

Ilizarov observation have shown that the rate of distraction by 0.5mm per day often drives to premature consolidation of the lengthened bone and that of 2.0mm per day often result in delay of a new bone tissue formation. Ilizarove established the optimum distraction rate as 1.0mm per day divided by four times with a rate of 0.25mm performed every 6 hours.



**BONE TRANPORATION OSTEOSYNTHESIS**

## METHOD OF COMPRESSION OSTEOGENESIS

The same technique used to produce distraction also are applicable for compression but in reverse direction. Slow rhythmic movement of one bone fragment towards the other. Parameters are speed, rhythm, distribution of forces on bone circumferences, rigidity of the bone fragment fixation, degree of damage of the bone marrow, the periosteal, soft tissues and the nutrient blood vessels at the level ofnon-union. Depending upon the type of non-union speed and rhythm are also different.

## PHYSIOTHERAPY DURING ILIZAROV FIXATION

Graduated gait training begins the first postoperative day . The patient should be encouraged to bear as much weight as tolerable on the operated limb with the aid of crutches or a walker.

During the course of postoperative fixator management , a patient's walking ability decreases , the surgeon must immediately determine the cause if the patient stops walking , bone density decreases.

Intensive physiotherapy is also necessary to prevent the joint contractures . Ankle equinus and knee flexion contractures are the two most common types of deformities that occur with lower limb elongation.

Fixed position orthoses or elastic band the foot to the fixator used in the management of patients.

Night positioning

The 7 or 8 hours that an individual spends in bed . The foot must be supported and prevented from dropping into planter fixation ,knee joint should be gently forced into full extension .

**METHOD OF UNIFIED DESIGNATION OF EXTERNAL FIXATION (MUDEF): [41]**

The type of transosseus element their levels and their crossing positions, the levels of the external supports of the fixator and the biomechanical relationship between the supports must be strictly regulated (normalized) .The standard and additional symbols were used in MUDEF

With the use of a minimal number of symbols, MUDEF of long bones provides a comprehensive description of the type and spatial orientation of the transosseus elements, the order and direction of their crossing and the form (geometry) and dimensions of the external supports, as well as the biomechanically indicated relationship between the supports.

MUDEF also has the following advantages:

1. Study of the method of external fixation: - accurate recording of thewhole algorithm of the operation and avoids failure of the methods due to inaccuracy and mistakes during its implementation

2. Elimination of pin induced damage to neurovascular structures
3. Estimating and detailing of complications

With the help of the coordinates each segment of the extremity is divided vertically (into levels) and horizontally (into positions).

Vertically each segment of the extremity is divided into eight basic and equally spaced levels designated by Roman Numerals from I to VIII. Each transverse section at each level is divided into 12 equal radiating sectors (similar to a clock-face). The sectors are defined by positions 1 to 12.

**COMPLICATION**

Complication of the Ilizarov Technique can be clasiified as

1.General Complication ,related to method

2.Specific Complication,related to technique

3.inflammatory complication

Dror paley[42] reported in 46 patient treated for bone transport for Limblenghthening were joint subluxation,muscle contracture,axialdeviation,neurological injury,vascular injury,premature

consolidation ,delayed consolidation,non union, pin site problems,implant failure and joint stiffness.Late complications are loss of length,late bowing and refracture.

**THE ILIZAROV FIXATOR USE IN INFECTED NON UNION TIBIA**

There are many reports of treatment of infected non-union of long bones using Ilizarov fixator available in the literature.

In 1988 Dror Paley,catagini,catanco et al[43] published their results.They reported 25 cases,13 of which were infected.All patients achieved union.Three of the infected patients had drainage at follow up.Four patients had residual deformity of more than 7.One patient had limb length inequality of more than 2.5 cm.According to that ASAM,system of grading the result 13 had excellent,5 were good,2 were fair and none were poor.

In 1991 Green et al[44] reported 17 patient in which 9 had septic non-union.Sixteen of these patients eventually united.Seven patients required bone grafting.Six was at the non-union site.One was at the Corticomy Site.One patient had amputation for persistent non-union.

In 1991 Cataneo,Cataginin and Johnson [45] reported 28 patients with infected non union of the Tibia.In 23 patients infection was eradicated .Three had refractures at the non-union site due to premature removal of the frame.Twenty one had good functional rating.

In 1995 Dandrions et al [46] reported 28 infected non-union of the Tibia treated with Ilizarov fixator.Fourteen patients had excellent bone union,eight were good one fair and five poor results.

Cierny et al [47] comparing treatment of segmental tibial defect conventional and lizarov methodologies. In this group final result were the same.The ilizarov group proved faster,safer,less expensive and easier to perform.

In 2006 Mehmet kocaoglu et al [48] studied 13 patients with Segmental bone defect of Femur and Tibia.Two stage of surgical treatment. First being debridement with antibiotic bead insertion .Second stage after 6 weeks bone transport using intramedullary nail and an ilizarov ring fixator.Study result showing reduced significantly the external fixation index and radiological consolidation index.

In 2007 El-Rosay et al [48] studied 21 Patients 11 infected non union and 10 open fractures.They are treated by debridement ,active

shortening and relenghthening after corticotomy.All fractures united and no deep infection.

In 2013 Mohamed Shahid,Abid Hussain,Phillipa Bridgeman,Deepa Bose[49] studied 12 patients.All was united .The mean time to union was 46 weeks .Six had an obvious limp.One had an appreciable ankle equinus and four had soft tissue dystrophy.Two patients had pin site infection.

In 2014,Peng Yin,Qun Zhang [51] retrospectively reviewed 66 patients with infected non union Tibia using the Ilizarov fixator.6 patients were lost to follow up.All the patients achieved bone union and no recurrence of infection.According to ASAMI 44 excellent,15 good,5 fair,2 poor,bone results and 24 excellent,26 good,10 fair and no poor functional results .

**CRITERIA FOR FIXATOR REMOVAL**

On radiodiagnosis the first new bone shadow can be seen as early as 3-4weeks after distraction is begun. The best way to evaluate regenerate development is to verify in computed tomographic (CT) scan .It is also to evaluate the regenerate sonographically.

Dynamizes the immobilized bone fragments and the regenerate between them by loosening the nuts all the sides of the connecting rod

attachments . the patient continues to apply the axial loading to the bone for 15-20 days more before the apparatus is removed.

Four most important factors in ilizarov fixator removal technique

1) The tension of al wires must be released before they are cut .
2) All olive wires must be removed by extraction towards the stopper.
3) Extraction of the wires with large pliers must be done strictly in the direction of the wire position and orientation in the bone .
4) Removal of the half –pins requires careful turning of the T- shaped hand drill.

Radiographic evaluation of healing in the operating room with anteroposterior and lateral films absolutely necessary .only after such evaluation can the decision to apply or not apply a cast be made.

# MATERIALS AND METHODS

This is the prospective study to evaluate the 20 patients with infected non-union tibia managed by Ilizarov fixation at Government Kilpauk Medical College Hospital for a period between August 2013 to August 2015.

## INCLUSION CRITERIA

1. Non-union (Brinker's definition)
2. Persistent discharge of atleast 3 months
3. Diaphyseal fractures non-union
4. Psychologically stable patients

## EXCLUSION CRITERIA

1. Acute fractures
2. Patients with pathological fractures
3. Patients unable to take self care

## INVESTIGATION DETAILS

1. Radiological : plain x ray of the affected limb in two standard projections
2. Complete hemogram

3. Renal function test
4. Pus culture and sensitivity
5. Bleeding and clotting time
6. Screening for infection – HIV,HBV,Syphilis
7. Chest x ray and Electocardiogram

The outcome is evaluated by using ASAMI score:

**BONE RESULTS:**

| | |
|---|---|
| Excellent | Union,no infection, deformity<7', limb length discrepancy <2.5 cm |
| Good | Union + any two of the following:<br>a) Absence of infection<br>b) Deformity <7'<br>c) Limb length inequality <2.5cm |
| Fair | Union + only one of the following:<br>a) Absence of infection<br>b) Deformity <7'<br>c) Limb length inequality <2.5cm |
| Poor | Non-union/refracture/union + infection + deformity >7' + limb length inequality >2.5cm |

**Functional results:**

| | |
|---|---|
| Excellent | Active, no limp, minimum stiffness (loss of 15’ knee extension/ 15’ dorsiflexion of ankle), no reflex sympathetic dystrophy (RSD), insignificant pain. |
| Good | Active with one or two of the following:<br>a) Limp<br>b) Stiffness<br>c) RSD<br>d) Significant pain |
| Fair | Active with three or all of the following:<br>a) Limp<br>b) Stiffness<br>c) RSD<br>d) Significant pain |
| Poor | Inactive (unemployment or inability to return to daily activities because of injury) |
| Failures | Amputation |

# SURGICAL TECHNIQUE

## PRE-OPERATIVE EVALUATION:

In the preoperative period all the patients were examined clinically and radiologically. Pus from discharging sinus sent for culture and sensitivity and socioeconomic status of the patient was assessed.

## CLINICAL EXAMINATION:

1. Personal history, 2. Family history, 3. Previous surgical history, 4. General health condition of the patient.

## X-RAY:

x-ray of the affected leg – anteroposterior view and lateral view including knee and ankle joint taken in all the patients.

## TEMPLATING:

Pre-operative templating made by using x-ray. Opposite extremity length is important for limb length and selection of ring size.

## SURGICAL TECHNIQUE

After administration of spinal anaesthesia, patient was placed in supine position on radiolucent table with sandbag under the thigh and another under the heel. The affected limb painted and draped from mid-thigh to foot.

Non-union site was exposed. Debridement done from the skin, fascia and muscles. Sequestrum was removed. If previous implants inside were removed, non-union site bone ends were excised till fresh bleeding visible. In our patients if gap found to be less than 2cm acute docking was made.

First ring placed below the knee joint and parallel to the joint line. First K-wire passed through the head of fibula and fixed with ring using wire fixation bolt. Second K-wire passed anterolateral to posteromedial, both K-wires were tensioned before fixing the ring. Whenever necessary additional schanz pins were used.

The distal ring was fixed just above the ankle joint. The intermittent rings were fixed with K-wires or olive wires, according to pre-operative templating. In our study corticotomy was done in 8 patients. Whenever required fibula osteotomy was done.Using c-arm the position of K-wires and non union site were checked, compression was given at the non union site if required. To avoid pin tract infection, we used betadine dressing for each pin tract.

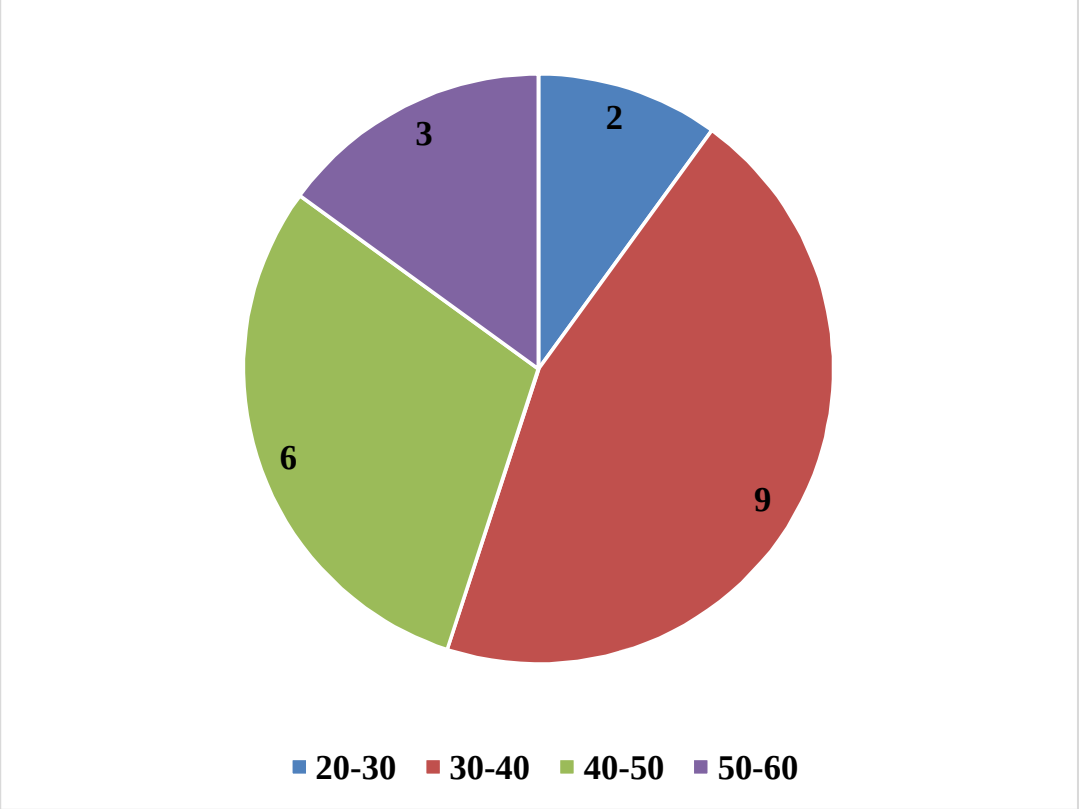
**POST-OPERATIVE FOLLOW UP:**

All the patients were taught about pin site care and physiotherapy. In patients whom corticotomy was done, distraction started on $7^{th}$ to $10^{th}$

day at the rate of 1mm/day – 0.25mm/$6^{th}$ hourly. Once pain subsides patient is mobilized with the help of a walker.All patients were discharged at a period of 2 weeks. In the patients whom corticotomy was done were discharged once they were able to do distraction on their own. All our patients were reviewed every 2 weeks and following parameters were reviewed – X-ray, wire breakage, joint stiffness, pain on walking, pin site infection, distal neurovascular deficit. The ring was removed after consolidation.

# OBSERVATION

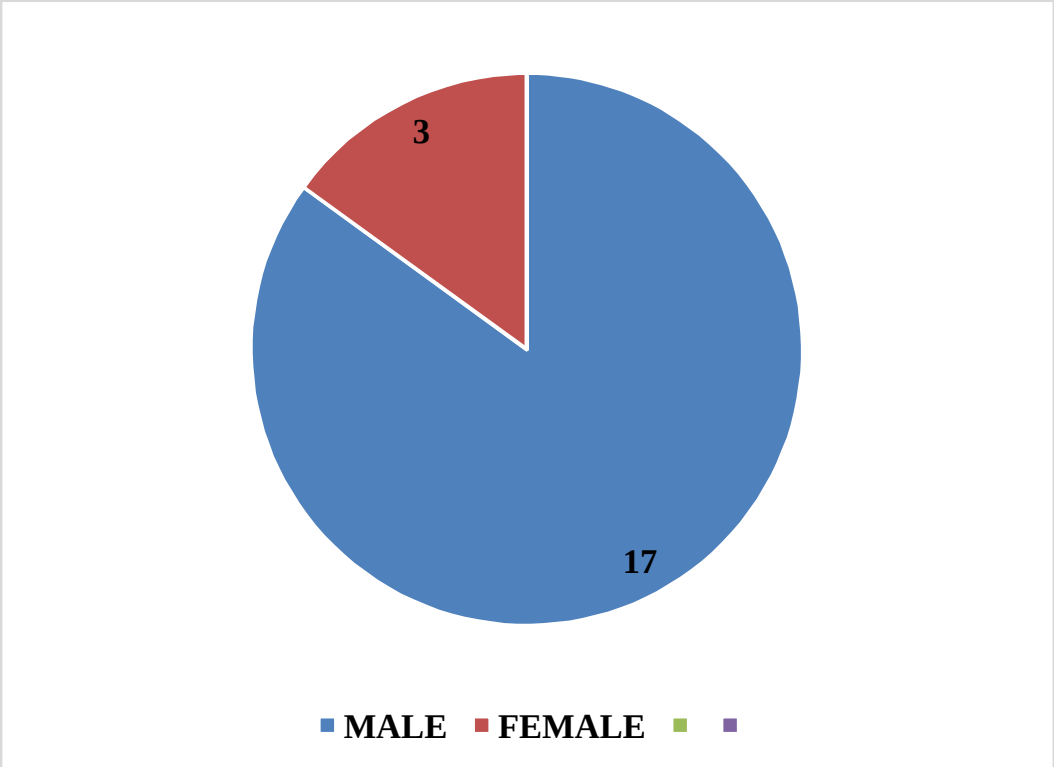
## AGE DISTRIBUTION




## TABLE - I

| AGE GROUP | NO.OF CASES | PERCENTAGE |
|---|---|---|
| 20-30 | 2 | 10% |
| 30-40 | 9 | 45% |
| 40-50 | 6 | 30% |
| 50-60 | 3 | 15% |

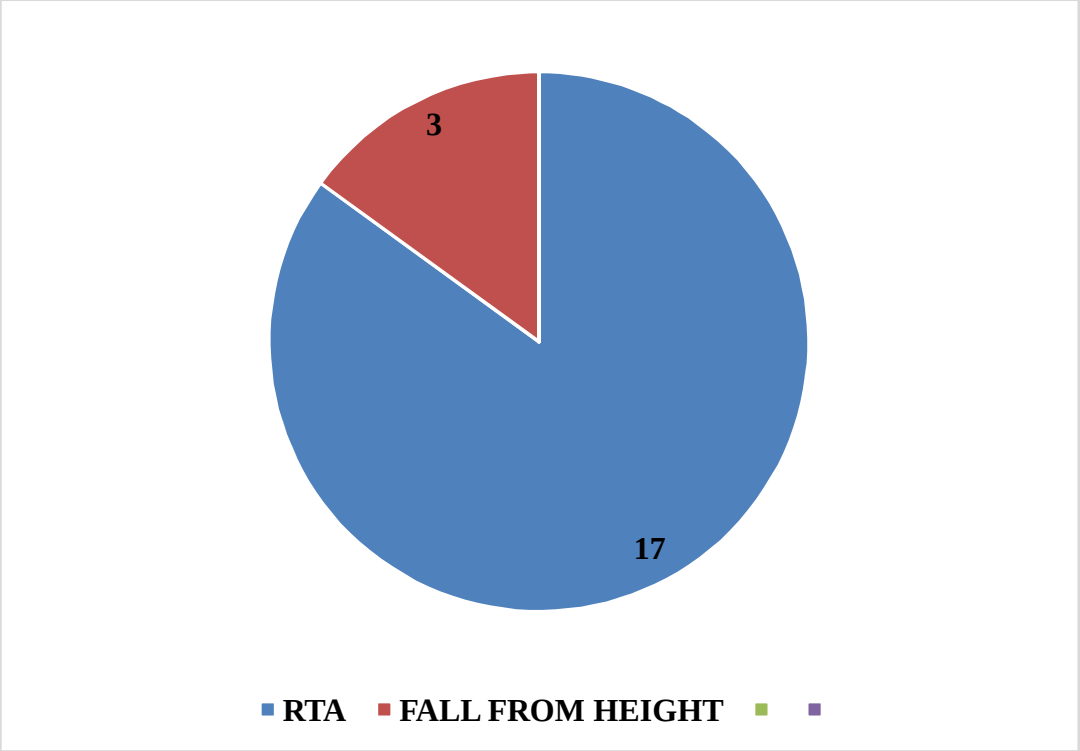
## SEX DISTRIBUTION




## TABLE - II

| SEX | NO OF CASES | PERCENTAGE |
|---|---|---|
| MALE | 17 | 85% |
| FEMALE | 3 | 15% |

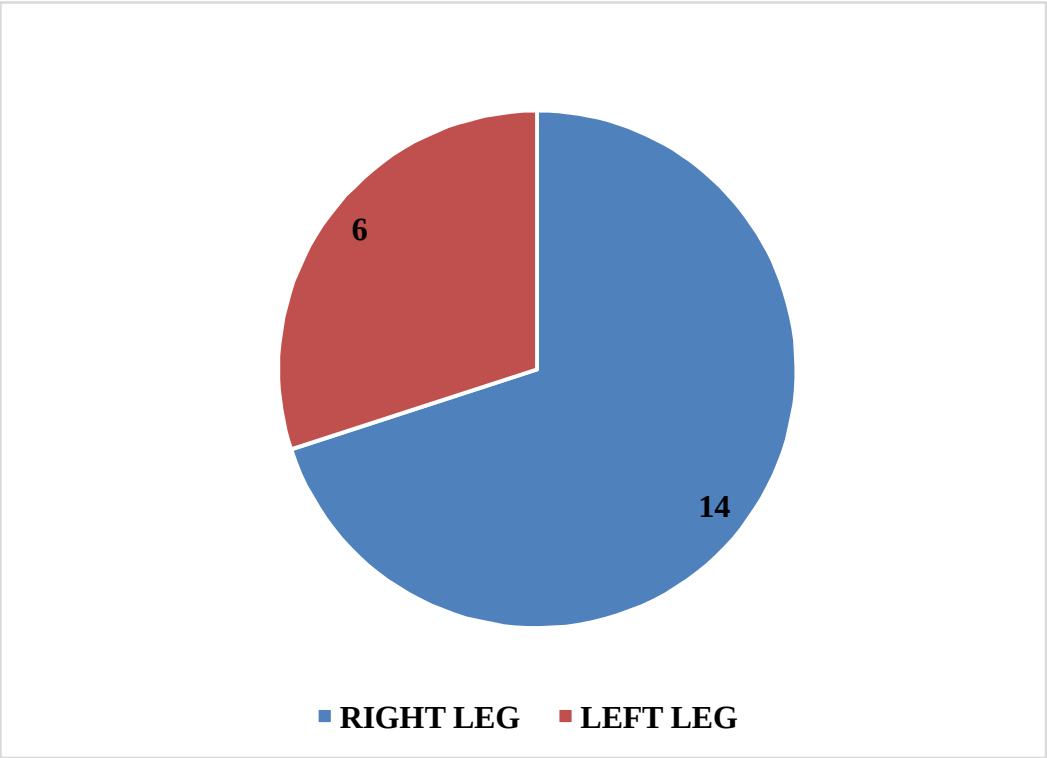
## MODE OF INJURY




## TABLE - III

| MODE OF INJURY | NO OF CASE | PERCENTAGE |
|---|---|---|
| RTA | 17 | 85% |
| FALL FROM HEIGHT | 3 | 15% |

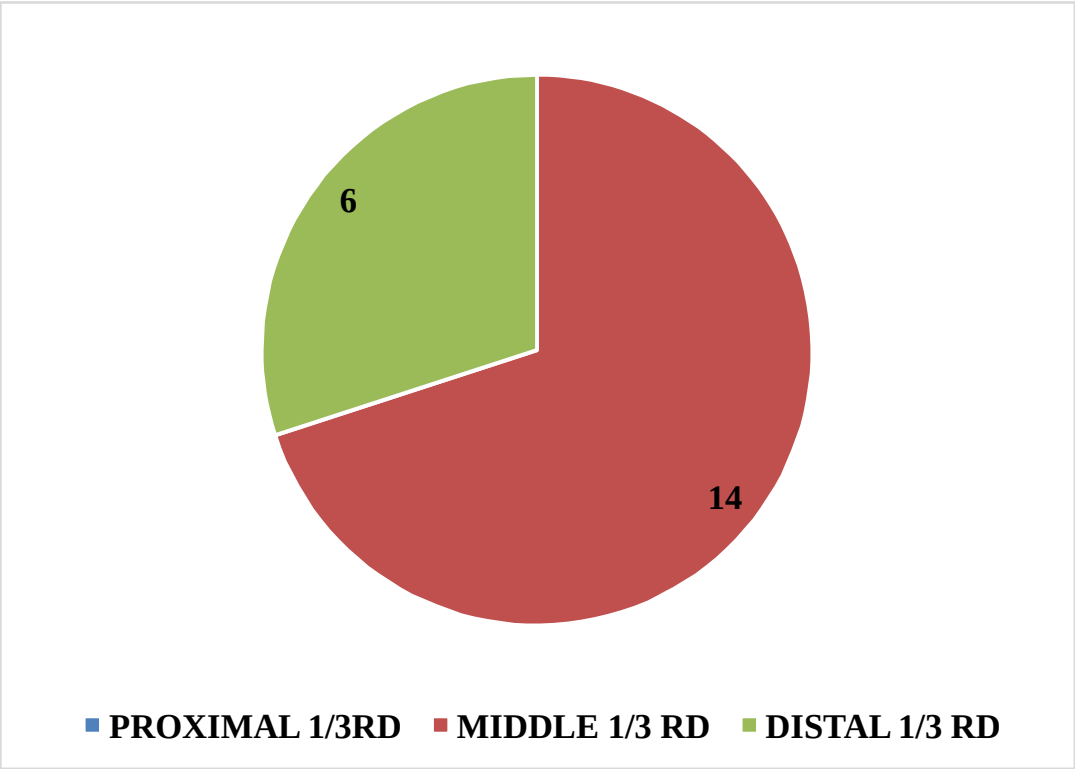
## SIDE OF AFFECTED LIMB




## TABLE - IV

| S.No | SIDE INVOLVED | No. OF PATIENTS |
|---|---|---|
| 1 | RIGHT LEG | 14 |
| 2 | LEFT LEG | 6 |

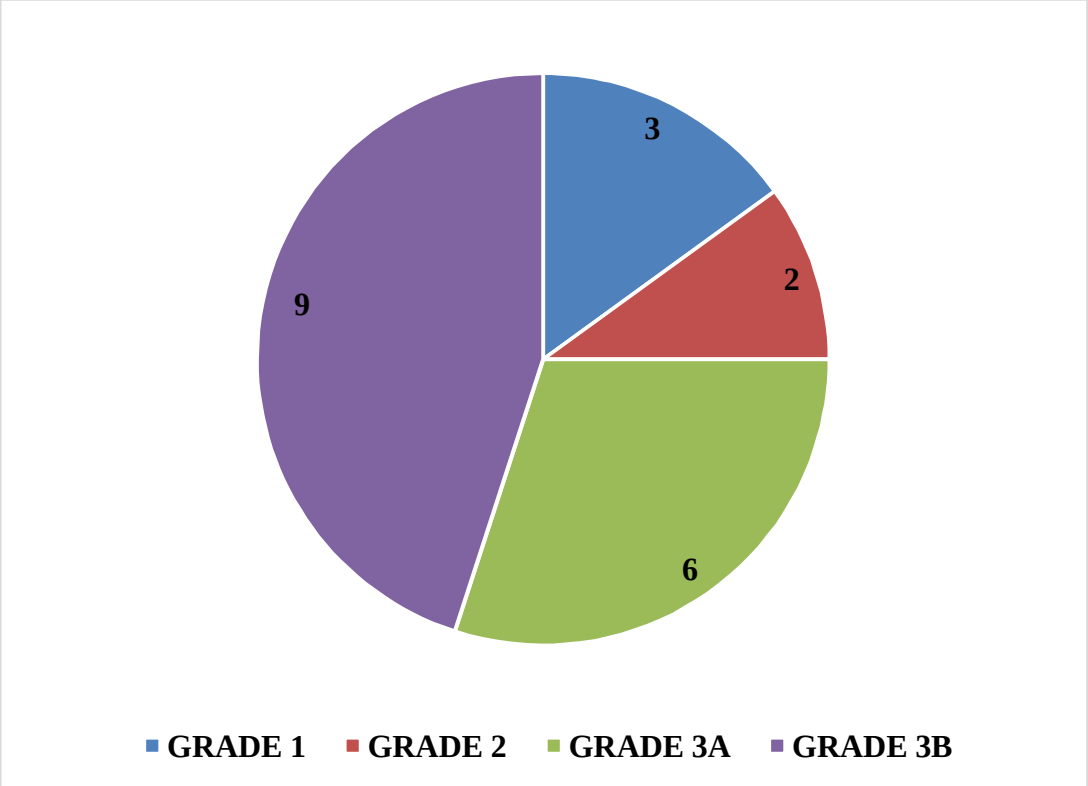
## SEGMENT INVOLVED




## TABLE V

| SEGMENT INVOLVED | No.OF PATIENTS |
|---|---|
| PROXIMAL TIBIA | 0 |
| MIDDLE TIBIA | 14 |
| DISTAL TIBIA | 6 |

## TYPE OF FRACTURE




## TYPE OF FRACTURE:

## GUSTILLO CLASSIFICATION:

| GRADE | No.OF CASES | PERCENTAGE |
|---|---|---|
| GRADE I | 3 | 15% |
| GRADE II | 2 | 10% |
| GRADE III A | 6 | 30% |
| GRADE III B | 9 | 45% |

**We used AO classification**

| PROXIMAL 1/3 TIBIA(41) | MIDDLE 1/3 TIBIA (42) | DISTAL 1/3 TIBIA (43) |
|---|---|---|
| NIL | 42.C3 | 43.A1 |
| | 42.C2 | 43.A3 |
| | 42.C2 | 43.A1 |
| | 42.B3 | 43.A1 |
| | 42.C2 | 43.A3 |
| | 42.B3 | 43.A2 |
| | 42.C2 | |
| | 42.B3 | |
| | 42.C2 | |
| | 42.C2 | |
| | 42.C3 | |
| | 42.B3 | |
| | 42.C2 | |
| | 42.B3 | |

- Majority of injured patients were males (85%)
- Highest number of patients were in their 3rd to 5th decade (75%)
- RTA was the most common mode of injury (85%)
- Majority of the injured patients were in Gustillotype III B (45%)
- Type 42.C2 of AO classification was the most common type out of 20 patients
- We encounter mostly middle third tibia fracture (14 patients)
- The shortest follow up period was 4 MONTHS and the longest follow up period was 12 MONTHS
- We encountered pin tract infection for two patients
- We did proximal tibialcorticotomy for 8 patients

# RESULTS

In our study 20 patients were followed up. Outcome was analysed based on:

1. Union
2. Complication
3. External fixation index (EFI)
4. Radiological consolidation index (RCI)
5. Bone results
6. Functional results

## 1. UNION:

In our 20 cases, union was achieved in 20 cases. One patient had refracture. Union time ranged between 2 to 7 months. Smoking, persistent infection, patient himself not able to walk, these factors affects the union. Early docking of the non union site were observed to shorten the union time.

## 2. COMPLICATIONS:

i) Refracture – one patient

ii) Pin site infection – six patients

iii) Joint stiffness – six patients

iv) Infection at non union site – six patients superficial infection one had deep infection

Infections were controlled by suitable antibiotics as per culture sensitivity and regular dressing.

## 3. EXTERNAL FIXATION INDEX(EFI):

The EFI is defined as duration of external fixation in days per amount of length in cm. In our 20 patients, distractive osteosynthesis was done in 8 patients. In our study, external fixation index was 98 days/cm.

| | |
|---|---|
| EFI in smokers | 111 days/cm |
| EFI in non-smokers | 88 days/cm |

## 4. RADIOLOGICAL CONSOLIDATION INDEX (RCI):

Radiological consolidation index is defined as appearance of consolidation of atleast 3 cortex in anteroposterior and lateral views in days/length in cm. in our study radiological consolidation index was 33 days/cm.

| | |
|---|---|
| RCI in smokers | 38/cm |
| RCI in non-smokers | 27/cm |

## 5. BONE RESULTS:

13 patients (65%) had excellent, 6 patients (30%) had good and 1patient (5%) had poor results. Union was achieved in all 20 patients. Out of 20 patients 6 had infection and none had deformity >7 degree and none Limb length discrepancy >2.5cm.

## 6. FUNCTIONAL RESULTS:

7 patients (35%) had excellent, 12 patients (60%) had good and 1 patient (5%) had fair results. The problems observed after functional assessment were:

1. Noticeable limping - 5 patients
2. Joint stiffness - 6 patients

# DISCUSSION

Infected non union is a challenging clinical problem even after decades of orthopaedic advancement in terms of fracture fixation , soft tissue management and antibiotic therapy.

Infection of the fracture site hinders the process of fracture healing. Hence effective control of the infection is warranted.

Debridement plays the first definitive step in the control of infection fixation of the fracture is then planned using ilizarov external fixator.

This study is about infected non union of tibia managed by ilizarov ring fixator. We have analysed the outcome by

1. Union time
2. complications
3. external fixation index
4. radiological consolidation index
5. bone and functional results

## 1. UNION TIME:

Union time ranged between 2-7 months. The mean union time of non union tibia by using ilizarov external fixator was nearly six months in study by G.K.Dendrinos et al(46) in 1995. Smoking is the main modifiable factor that mainly affects union rates, so all my patients were advised to quit smoking.

## 2. COMPLICATIONS:

Infection is one of the major complications in our study. Six patients had either pin tract infection or non union site infection or both. Infection were controlled by suitable antibiotics as per culture sensitivity and regular dressing. Limb edema was controlled by proper limb elevation. In patients who underwent distraction osteosynthesis distal joint stiffness were noticed because muscle responds poorly to distraction rate. Joint stiffness was observed in 6 cases which was improved by suitable physiotherapy. One patients had refracture. No serious vascular or neurological complications were noted. 28 infected non union of tibia studied by G.K.Dendrinos et al(46) had 3 non union 1 refracture, 13 joint stiffness, 11 axial deviation.

## 3. EXTERNAL FIXATION INDEX:

In our study external fixation index was 98days/cm, it was longer in smokers because smoking cause vasoconstrictive effect of nicotine that inhibits tissue differentiation, angiogenic response which is necessary in early stages of healing. Osteoblast function is inhibited by nicotine. Smoking affects union time and radiological consolidation index and external fixation index. In a study by Bobroff at al(52) in treatment of large bone defects in tibia, 2month/cm is the mean, 1.45 month/cm in non-smokers and 2.6month /cm in smokers.

## 4. RADIOLOGICAL CONSOLIDATION INDEX:

Corticotomy was done for 8 patients. Bone grafting was not done in any cases. Radiological consolidation index is influenced by smoking. In our study RCI was 32 days per cm in smokers 38 days per cm and non smokers 27 days per cm.

## 5. BONE AND FUNCTIONAL RESULTS:

According to ASAMI score

| RESULTS | Our results 20 patients | | Dendrinos et al 28 pts | | Lalit et al 23 pts | |
|---|---|---|---|---|---|---|
| | Bone | Functional result | Bone | Functional result | Bone | Functional Result |
| Excellent | 65% | 35% | 50% | 25% | 66.7% | 26.7% |
| Good | 30% | 60% | 28.5% | 47% | 13.3% | 40% |
| Fair | - | 5% | 3.5% | 14% | - | 10% |
| Poor | 5% | - | 18% | 14% | 20% | 23.3% |

# STATISTICAL ANALYSIS

## Crosstabs

### BONE RESULT * GUSTILO ANDERSON

**Crosstab**

Count

| | | GUSTILO ANDERSON | | | | |
|---|---|---|---|---|---|---|
| | | I | II | IIIA | IIIB | Total |
| BONE RESULT | 1 | 3 | 0 | 5 | 5 | 13 |
| | 2 | 0 | 1 | 0 | 5 | 6 |
| | 4 | 0 | 1 | 0 | 0 | 1 |
| Total | | 3 | 2 | 5 | 10 | 20 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 16.154[a] | 6 | .013 |
| Likelihood Ratio | 15.004 | 6 | .020 |
| N of Valid Cases | 20 | | |

a. 11 cells (91.7%) have expected count less than 5. The minimum expected count is .10.

### FUNCTIONAL RESULT * GUSTILO ANDERSON

**Crosstab**

Count

| | | GUSTILO ANDERSON | | | | |
|---|---|---|---|---|---|---|
| | | I | II | IIIA | IIIB | Total |
| FUNCTIONAL RESULT | 1 | 1 | 1 | 2 | 3 | 7 |
| | 2 | 2 | 1 | 3 | 6 | 12 |
| | 3 | 0 | 0 | 0 | 1 | 1 |
| Total | | 3 | 2 | 5 | 10 | 20 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 1.294[a] | 6 | .972 |
| Likelihood Ratio | 1.668 | 6 | .948 |
| N of Valid Cases | 20 | | |

a. 11 cells (91.7%) have expected count less than 5. The minimum expected count is .10.

## Crosstabs

**UNION TIME * DIAGNOSIS Crosstabulation**

Count

| | | DIAGNOSIS | | |
|---|---|---|---|---|
| | | INU-D3 | INU-M3 | Total |
| UNION TIME | 2m | 1 | 1 | 2 |
| | 3m | 3 | 5 | 8 |
| | 4m | 2 | 5 | 7 |
| | 6m | 0 | 2 | 2 |
| | 7m | 0 | 1 | 1 |
| Total | | 6 | 14 | 20 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 1.888[a] | 4 | .756 |
| Likelihood Ratio | 2.701 | 4 | .609 |
| N of Valid Cases | 20 | | |

a. 9 cells (90.0%) have expected count less than 5. The minimum expected count is .30.

## Crosstabs

**UNION TIME * COMORBIDITY Crosstabulation**

Count

| | | COMORBIDITY | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1. | 2. | 3,4 | 3. | 4. | Total |
| UNION TIME | 2m | 1 | 1 | 0 | 0 | 0 | 2 |
| | 3m | 5 | 0 | 0 | 2 | 1 | 8 |
| | 4m | 4 | 1 | 0 | 2 | 0 | 7 |
| | 6m | 2 | 0 | 0 | 0 | 0 | 2 |
| | 7m | 0 | 0 | 1 | 0 | 0 | 1 |
| Total | | 12 | 2 | 1 | 4 | 1 | 20 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 27.470[a] | 16 | .037 |
| Likelihood Ratio | 15.772 | 16 | .469 |
| N of Valid Cases | 20 | | |

a. 25 cells (100.0%) have expected count less than 5. The minimum expected count is .05.

## Crosstabs

**UNION TIME * SMOKING Crosstabulation**

Count

| | | SMOKING | | |
|---|---|---|---|---|
| | | 1 | 2 | Total |
| UNION TIME | 2m | 0 | 2 | 2 |
| | 3m | 4 | 4 | 8 |
| | 4m | 4 | 3 | 7 |
| | 6m | 0 | 2 | 2 |
| | 7m | 1 | 0 | 1 |
| Total | | 9 | 11 | 20 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 4.993[a] | 4 | .288 |
| Likelihood Ratio | 6.874 | 4 | .143 |
| N of Valid Cases | 20 | | |

a. 10 cells (100.0%) have expected count less than 5. The minimum expected count is .45.

## Crosstabs

**BONE RESULT * CORTICOTOMY Crosstabulation**

Count

| | | CORTICOTOMY | | |
|---|---|---|---|---|
| | | NO | YES | Total |
| BONE RESULT | 1 | 8 | 5 | 13 |
| | 2 | 3 | 3 | 6 |
| | 4 | 1 | 0 | 1 |
| Total | | 12 | 8 | 20 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | .929[a] | 2 | .628 |
| Likelihood Ratio | 1.279 | 2 | .527 |
| N of Valid Cases | 20 | | |

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .40.

## BONE RESULT * CORTICOTOMY

**Crosstab**

Count

| | | CORTICOTOMY | | |
|---|---|---|---|---|
| | | NO | YES | Total |
| BONE RESULT | 1 | 8 | 5 | 13 |
| | 2 | 3 | 3 | 6 |
| | 4 | 1 | 0 | 1 |
| Total | | 12 | 8 | 20 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | .929[a] | 2 | .628 |
| Likelihood Ratio | 1.279 | 2 | .527 |
| N of Valid Cases | 20 | | |

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .40.

## FUNCTIONAL RESULT * CORTICOTOMY

**Crosstab**

Count

| | | CORTICOTOMY | | |
|---|---|---|---|---|
| | | NO | YES | Total |
| FUNCTIONAL RESULT | 1 | 4 | 3 | 7 |
| | 2 | 8 | 4 | 12 |
| | 3 | 0 | 1 | 1 |
| Total | | 12 | 8 | 20 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 1.746[a] | 2 | .418 |
| Likelihood Ratio | 2.083 | 2 | .353 |
| N of Valid Cases | 20 | | |

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .40.

# CONCLUSION

* Ilizarov system allows early ambulant thus decreasing chances of osteoporosis and soft tissue dystrophy.

* Average union rate was found out to be 3.5 months and was influenced by communition, infection, non union type, smoking and fracture pattern.

* In our case Ilizarov fixator provides 100% union rate.

* Compliance of the patients is the major factor that influences the result of the study.

* Even through ilizorov ring fixator is an external fixator still it can be concealed by proper dressing so that patient can continue his / her regular day to day activity.

* Ilizarov ring fixation is the safest, simplest, most economical and effective method for management of infected non union tibia.

# ILLUSTRATIVE CASES

## 1.CASE 1:

Munusamy 45/M. A case of fracture both bone right leg with plating done. He came with deformed leg exposing hardware and discharging sinus and was diagnosed as infected non-union right leg for which ilizarov fixation was done after removing the plate.

**Ilizarov events:**

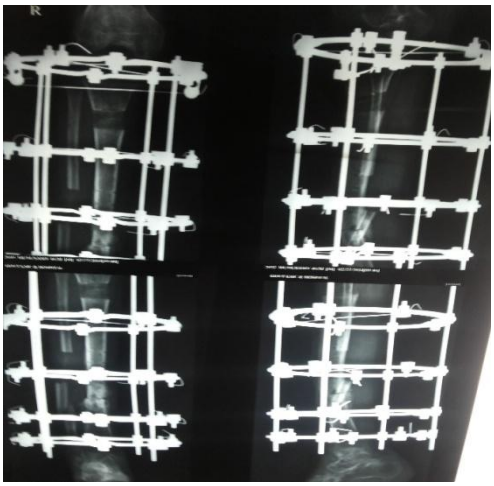
Pre operative limb length discrepancy – 4cm

| | | |
|---|---|---|
| Rings used | - | 5 |
| Corticotomy | - | yes |
| Latency | - | 7 days |
| Rate of transport | - | 1mm/day |
| Rhythm | - | 0.25mm $6^{th}$ hourly |
| Total Duration | - | 12months |

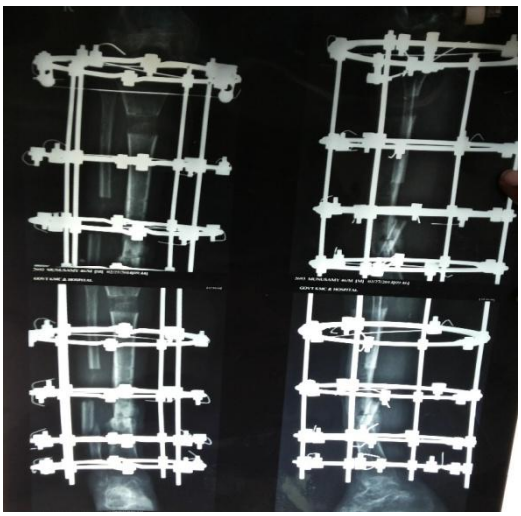
## Preoperative Xray

## Preoperative Clinical Picture

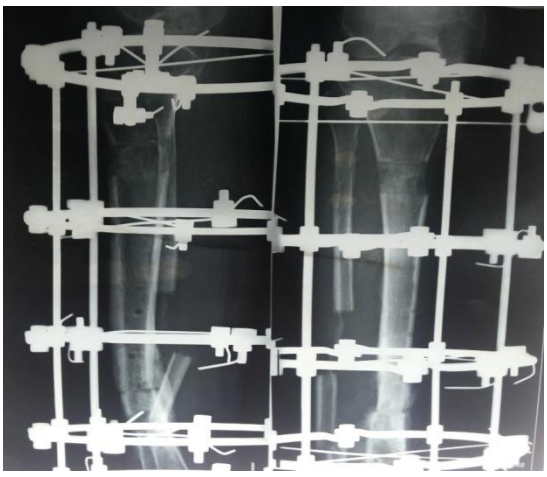
## Postoperative Xray



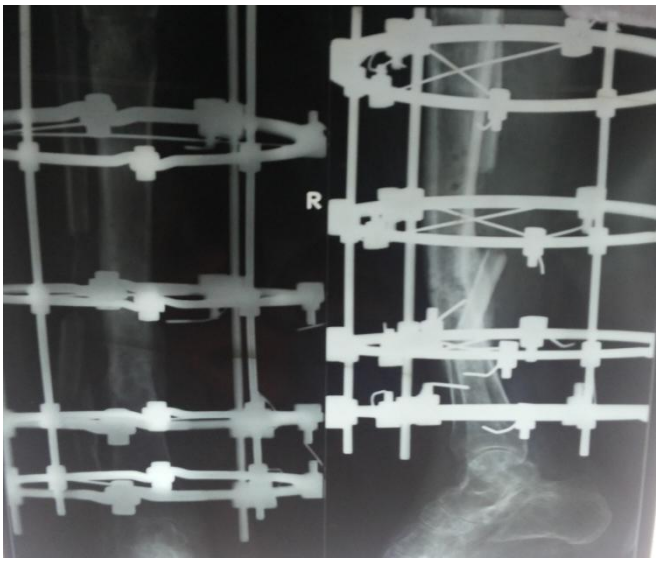
## 2 month followup



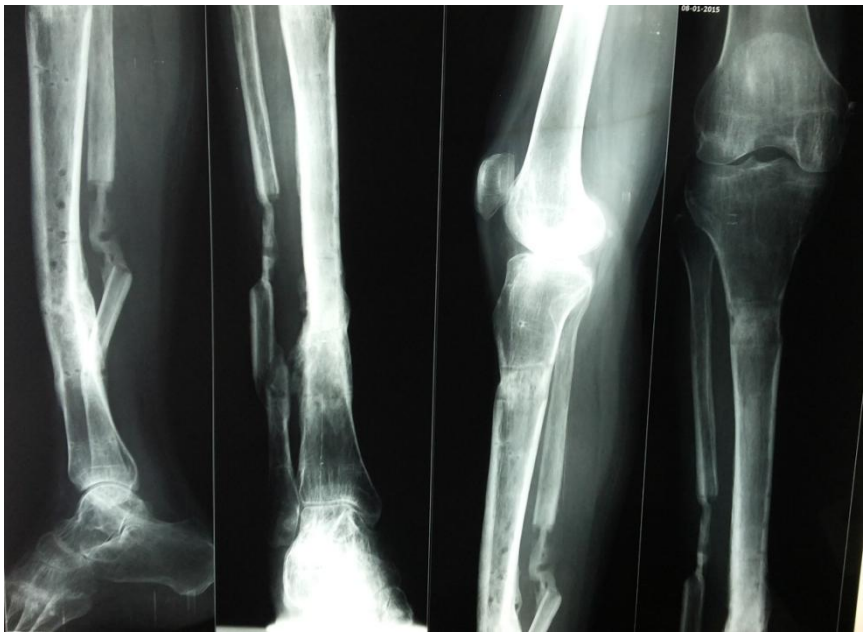
## 4 month followup



## 6 month followup




## After Ilizarov Ring Removal



# CLINICAL PICTURES

**2. CASE NO. 7**

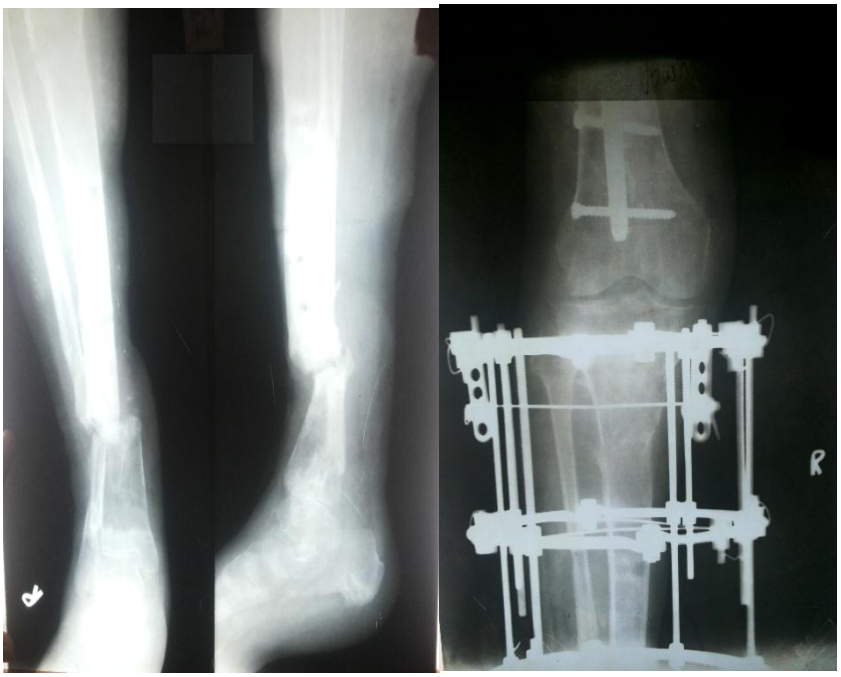
Kumar 35/M. Patient had road traffic accident 4 years before and sustained Grade IIIB compound fracture both bone right leg with closed right femur fracture and Grade II compound fracture both bone left leg. Now he presented with united right femur and left leg fractures and infected non-union of right both bone leg at middle and distal third junction. Ilizarov fixation done for right leg.

Ilizarov events:

Pre operative limb length discrepancy – 3 cm

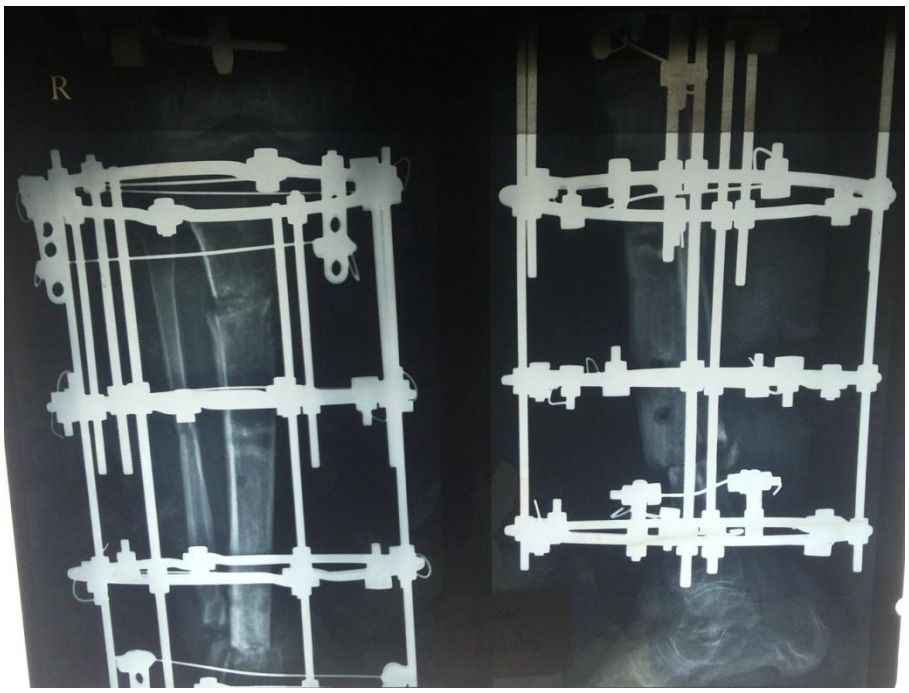
| | | |
|---|---|---|
| Rings used | - | 4 rings |
| Corticotomy | - | proximal tibial level |
| Latency | - | 7 days |
| Rate of transport | - | 1mm/day |
| Rhythm | - | ¼ turn $6^{th}$ hourly |
| Total Duration | - | 9 months |
| Secondary procedures | - | Nil |
| Complications | - | Nil |

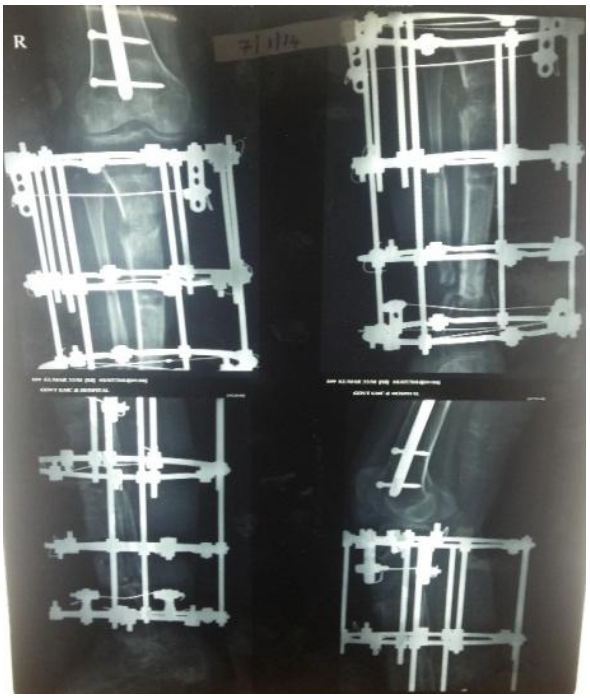
**Pre-op X-ray** **Immediate Postoperative Xray**




**Immediate Postoperative Xray**

**1 month Followup Xray**




**2 month followup Xray**

## 6 month followup Xray

## Xray after ring removal

# CLINICAL PICTURES

**3.CASE NO 11:**

Shankar 48/M. Patient had road traffic accident 2 years before and diagnosed as Grade I compound fracture both bone left leg for which IMIL nailing was done after 15 days. Infected distal screws removed. After 1 year he was diagnosed as infected non-union both bone left leg distally. Ilizarov was done.

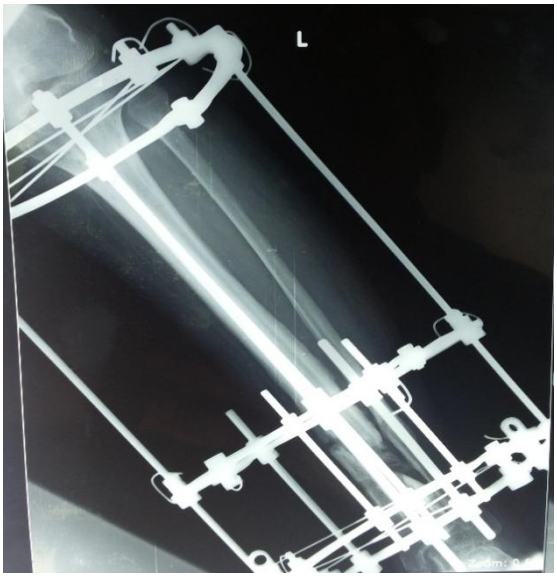
Ilizarov events:

| | |
|---|---|
| Pre operative limb length discrepancy | – Nil |
| Rings used | - 3 rings |
| Corticotomy | – Not done |
| Total Duration | - 4 months |
| Secondary procedures | – Nil |
| Complications | – Nil |

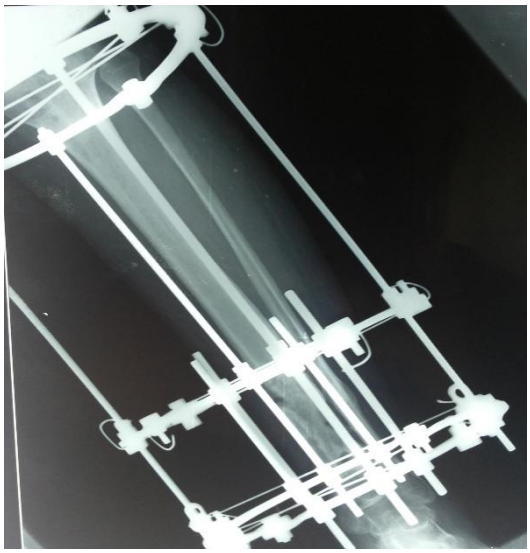
Preoperative Clinical Pictures

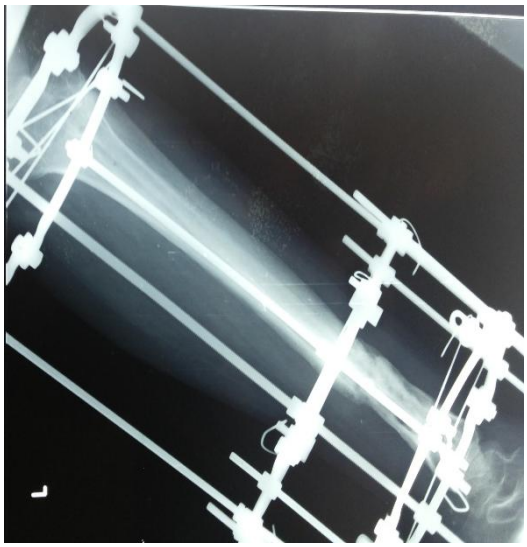
## Preoperative Xrays

## Immediate Postoperative Xray

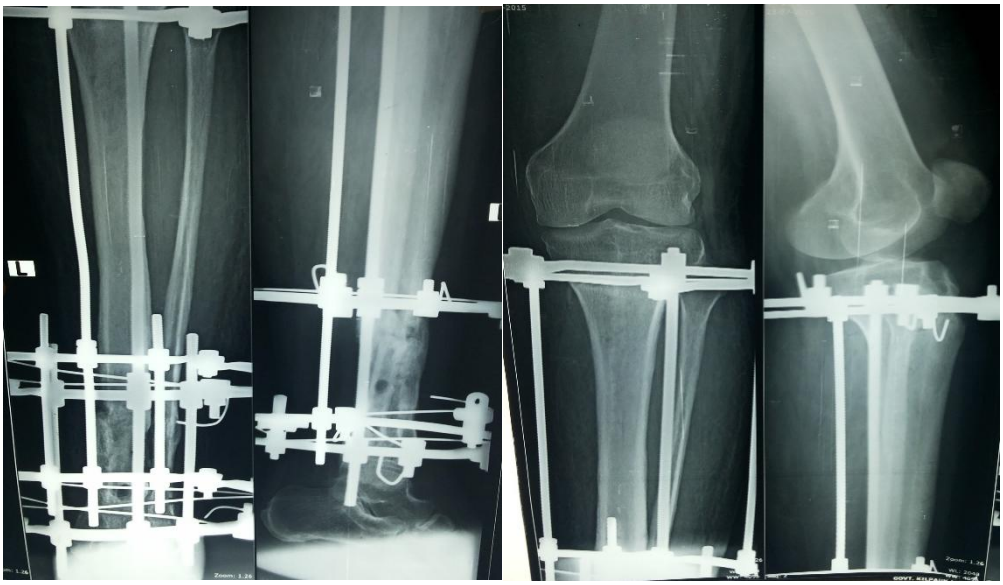



## 1 month followup Xray





## 2 month folowup Xray



## After Ilizarov Fixator Removal Xray

# CLINICAL PICTURES

**4.CASE 4:**

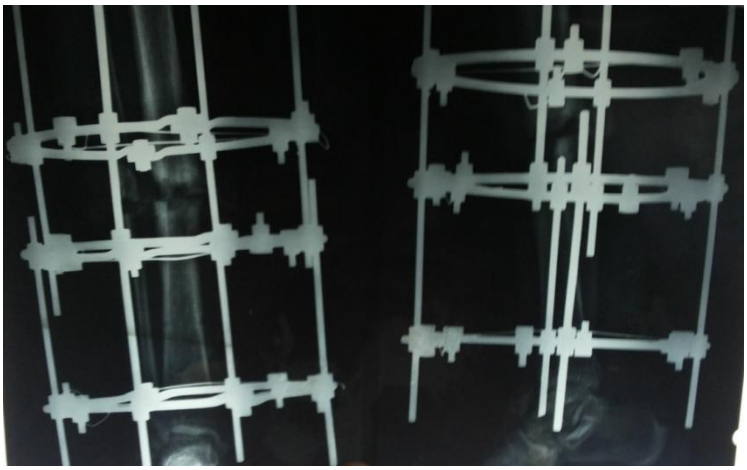
Nithya kumar, 34/M. Patient had road traffic accident and diagnosed as Grade II compound fracture both bone right leg for which ORIF with IM/IL nailing done for right tibia. After 2 months IMIL nail was replaced with antibiotic coated IM/IL nail as it gets infected. Later on he was diagnosed as infected non-union both bone right leg. Antibiotic coated IMIL nail was removed and Ilizarov fixation was done.

Ilizarov events:

| | | |
|---|---|---|
| Preoperative limb length discrepancy | - | Nil |
| Rings used | - | 4 rings |
| Corticotomy | - | Not done |
| Total Duration | - | 6months |

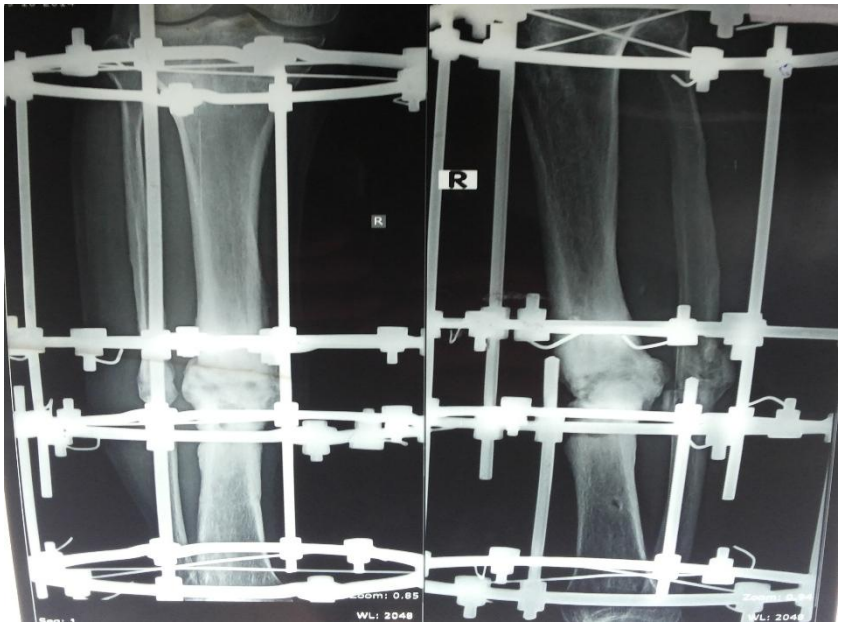
## PRE OPERATIVE X-RAY


## IMMEDIATE POSTOPERATIVE XRAY

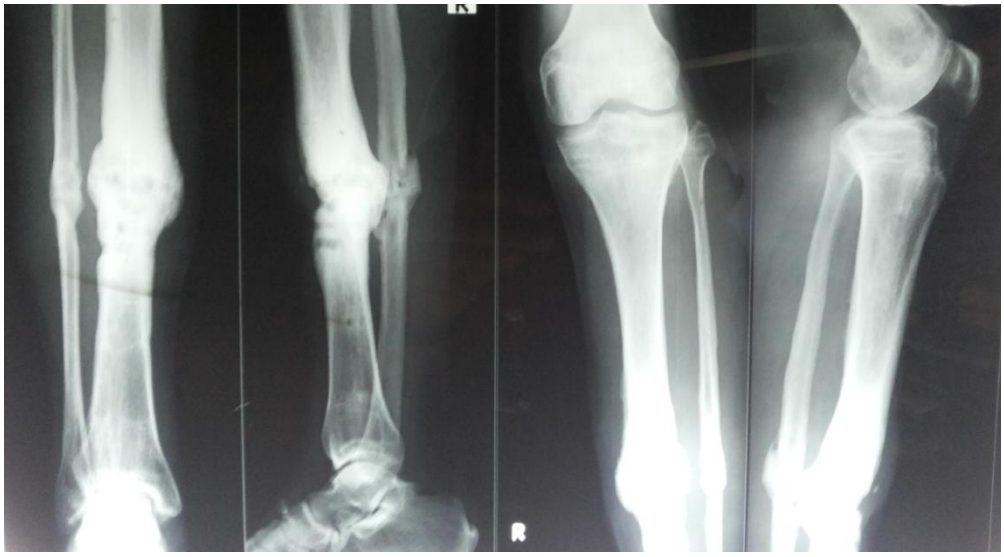


## 2 MONTH POSTOPERATIVE XRAY

## 5 MONTH POSTOPERATIVE




## AFTER ILIZAROV FIXATOR REMOVAL



# CLINICAL PICTURES

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# MASTER CHART

| CASE | NAME | AGE | SEX | MODE OF INJURY | SIDE | FRACTURE AT THE TIME OF INJURY | GUSTILO ANDERSON | PRE-OP SHORTENING | COMORBIDITY | DIAGNOSIS | KNEE-ROM | ANKLE DF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MUNUSAMY | 45 | 1 | 1 | 1 | 43A1 | IIIB | 4CM | 1 | INU-D3 | 100 | 5 |
| 2 | ANTONY RAJ | 56 | 1 | 1 | 1 | 43A3 | IIIA | 2CM | 1 | INU-D3 | 90 | 10 |
| 3 | SARAVANA | 43 | 1 | 1 | 1 | 42B3 | IIIB | NO | 1 | INU-M3 | 100 | 10 |
| 4 | NITHYA KUMAR | 38 | 1 | 1 | 1 | 43B3 | II | NO | 3 | INU-M3 | 100 | 10 |
| 5 | GOMATHI | 40 | 2 | 2 | 1 | 42C2 | IIIA | NO | 1 | INU-M3 | 120 | 15 |
| 6 | VINOTH | 35 | 1 | 1 | 2 | 43B3 | IIIB | NO | 2 | INU-M3 | 90 | 10 |
| 7 | KUMAR | 36 | 1 | 1 | 1 | 43A1 | IIIB | 3CM | 1 | INU-D3 | 90 | 5 |
| 8 | YUVARAJ | 45 | 1 | 1 | 1 | 42C2 | IIIB | NO | 4 | INU-M3 | 60 | 5 |
| 9 | BABU | 39 | 1 | 2 | 1 | 42B3 | I | NO | 2 | INU-M3 | 70 | 10 |
| 10 | RAMAN | 32 | 1 | 1 | 2 | 42C2 | IIIB | 3CM | 3 | INU-M3 | 90 | 15 |
| 11 | SHANKAR | 37 | 1 | 1 | 2 | 43A1 | I | NO | 1 | INU-D3 | 100 | 10 |
| 12 | VIJAYA DEVI | 33 | 2 | 1 | 1 | 42C2 | IIIA | NO | 1 | INU-M3 | 80 | 10 |
| 13 | DEVA | 27 | 1 | 1 | 2 | 43A3 | IIIB | 3CM | 3 | INU-D3 | 80 | 5 |
| 14 | RAJA | 49 | 1 | 1 | 1 | 42C2 | IIIB | NO | 1 | INU-M3 | 80 | 10 |
| 15 | MURUGAN | 36 | 1 | 1 | 2 | 42C3 | IIIB | 2CM | 1 | INU-M3 | 90 | 5 |
| 16 | SELVAM | 42 | 1 | 1 | 1 | 42C3 | IIIA | NO | 1 | INU-M3 | 90 | 15 |
| 17 | SARALA | 53 | 2 | 2 | 1 | 42C2 | I | NO | 3,4 | INU-M3 | 100 | 10 |
| 18 | PALANIAPPAN | 38 | 1 | 1 | 1 | 43A2 | IIIB | 4CM | 1 | INU-D3 | 80 | 5 |
| 19 | MARIMUTHU | 24 | 1 | 1 | 1 | 43B3 | IIIA | 4CM | 3 | INU-M3 | 90 | 5 |
| 20 | MOORTHY | 51 | 1 | 1 | 2 | 42C3 | II | NO | 1 | INU-M3 | 80 | 10 |

| CASE | NAME | ANKLE PF | DEFORMITY | INFECTIVE ORGANISM | NO OF PREVIOUS SURGERIES | TYPE OF NONUNION | ADD SURGERY | CORTICOTOMY | BI/UNIFOCAL | FRAME | CONSOLIDATION | UNION TIME | TOTAL DUARTION | SMOKING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MUNUSAMY | 10 | AP-15 | 1,2 | 2 | B2 | 0 | YES | 1 | 5 | 1 | 4m | 12m | 2 |
| 2 | ANTONY RAJ | 15 | NO | 3 | 2 | B2 | 1 | YES | 1 | 5 | 1 | 3m | 9m | 1 |
| 3 | SARAVANA | 20 | VARUS-12 | 0 | 1 | A2.1 | 0 | NO | 0 | 4 | 0 | 3m | 4m | 1 |
| 4 | NITHYA KUMAR | 15 | NO | 0 | 2 | A2.1 | 0 | NO | 0 | 4 | 0 | 3m | 6m | 2 |
| 5 | GOMATHI | 10 | VALGUS-7 | 1,4 | 1 | A1 | 0 | NO | 0 | 4 | 0 | 4m | 6m | 2 |
| 6 | VINOTH | 20 | NO | 0 | 1 | A2.1 | 0 | NO | 0 | 4 | 0 | 4m | 6m | 1 |
| 7 | KUMAR | 10 | NO | 0 | 3 | B2 | 0 | YES | 1 | 4 | 1 | 3m | 9m | 2 |
| 8 | YUVARAJ | 15 | NO | 5 | 1 | A2.1 | 0 | NO | 0 | 4 | 0 | 3m | 4m | 1 |
| 9 | BABU | 10 | VARUS-12 | 0 | 1 | A2.1 | 0 | NO | 0 | 4 | 0 | 2m | 4m | 2 |
| 10 | RAMAN | 20 | NO | 3 | 1 | B1 | 0 | YES | 1 | 5 | 1 | 3m | 9m | 1 |
| 11 | SHANKAR | 20 | NO | 0 | 3 | A2.1 | 0 | NO | 0 | 3 | 0 | 2m | 4m | 2 |
| 12 | VIJAYA DEVI | 15 | NO | 0 | 1 | A2.1 | 0 | NO | 0 | 4 | 0 | 4m | 5m | 2 |
| 13 | DEVA | 10 | NO | 3 | 3 | B2 | 1 | YES | 1 | 5 | 1 | 4m | 10m | 1 |
| 14 | RAJA | 15 | VARUS-6 | 0 | 2 | A1 | 0 | NO | 0 | 4 | 0 | 3m | 4m | 2 |
| 15 | MURUGAN | 10 | NO | 2,4 | 1 | B2 | 0 | YES | 1 | 5 | 1 | 4m | 12m | 1 |
| 16 | SELVAM | 15 | NO | 3 | 2 | A2.1 | 0 | NO | 0 | 4 | 0 | 6m | 8m | 2 |
| 17 | SARALA | 10 | VARUS-12 | 3 | 2 | A1 | 0 | NO | 0 | 4 | 0 | 7m | 8m | 1 |
| 18 | PALANIAPPAN | 15 | NO | 0 | 2 | B2 | 1 | YES | 1 | 5 | 1 | 3m | 9m | 2 |
| 19 | MARIMUTHU | 20 | NO | 3 | 1 | B2 | 0 | YES | 1 | 5 | 1 | 4m | 12m | 1 |
| 20 | MOORTHY | 20 | NO | 0 | 3 | A2.1 | 0 | NO | 0 | 4 | 0 | 6m | 8m | 2 |

| CASE | NAME | REFRACTU | REVERSE CONSOLID | PIN SITE IN | UNITED | INFECTION | DEFORMIT | LLD | BONE RES | ACTIVE | LIMP | KNEE ROM | ANKLE DF | ANKLE PF | RSD | PAIN | FUNCTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MUNUSAMY | 2 | YES | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 90 | 15 | 20 | 2 | 2 | 1 |
| 2 | ANTONY RAJ | 2 | YES | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 80 | 10 | 15 | 2 | 2 | 2 |
| 3 | SARAVANA | 2 | NO | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 100 | 15 | 10 | 2 | 2 | 2 |
| 4 | NITHYA KUMAR | 1 | NO | 1 | 1 | 2 | 1 | 2 | 4 | 2 | 2 | 120 | 15 | 30 | 2 | 2 | 1 |
| 5 | GOMATHI | 2 | NO | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 120 | 15 | 20 | 2 | 2 | 1 |
| 6 | VINOTH | 2 | NO | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 110 | 15 | 15 | 2 | 2 | 2 |
| 7 | KUMAR | 2 | YES | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 90 | 10 | 20 | 2 | 2 | 1 |
| 8 | YUVARAJ | 2 | NO | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 100 | 15 | 5 | 2 | 2 | 2 |
| 9 | BABU | 2 | NO | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 100 | 15 | 15 | 2 | 2 | 2 |
| 10 | RAMAN | 2 | YES | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 80 | 5 | 10 | 2 | 2 | 2 |
| 11 | SHANKAR | 2 | NO | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 120 | 20 | 30 | 2 | 2 | 1 |
| 12 | VIJAYA DEVI | 2 | NO | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 100 | 15 | 15 | 2 | 2 | 2 |
| 13 | DEVA | 2 | YES | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 80 | 10 | 10 | 2 | 1 | 3 |
| 14 | RAJA | 2 | NO | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 110 | 15 | 20 | 2 | 2 | 1 |
| 15 | MURUGAN | 2 | YES | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 60 | 5 | 5 | 2 | 2 | 2 |
| 16 | SELVAM | 2 | NO | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 100 | 20 | 20 | 2 | 2 | 2 |
| 17 | SARALA | 2 | NO | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 110 | 15 | 15 | 2 | 1 | 2 |
| 18 | PALANIAPPAN | 2 | YES | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 60 | 5 | 10 | 2 | 2 | 2 |
| 19 | MARIMUTHU | 2 | YES | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 100 | 15 | 20 | 2 | 2 | 1 |
| 20 | MOORTHY | 2 | NO | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 80 | 5 | 15 | 2 | 2 | 2 |

# KEY TO MASTER CHART

1. NAME
2. AGE
3. SEX  1-MALE; 2-FEMALE
4. MODE OF INJURY 1-RTA; 2-FALL FROM HEIGHT
5. SIDE 1-RIGHT; 2-LEFT
6. FRACTURE – MULLER AO CLASSIFICATION

   41-PROXIMAL FRACTURES

   42-DIAPHYSEAL FRACTURE

   42A-SIMPLE FRACTURES; A1-SPIRAL; A2-OBLIQUE; A3-TRANSVERSE

   42B-WEDGE FRACTURE; B1-SPIRAL; B2-BENDING WEDGE; B3-FRAGMENTED WEDGE

   42C-COMPLEX FRACTURE; C1-SPIRAL; C2-SEGMENTAL; C3-IRREGULAR

   43-DISTAL FRACTURE

   43A-EXTRA-ARTICULAR FRACTURE; A1-SIMPLE; A2-WEDGE; A3-COMPLEX

43B-PARTIAL ARTICULAR FRACTURE; B1-PURE SPLIT; B2-SPLIT-DEPRESSION; B3-MULTIFRAGMENTARY DEPRESSION

43C-COMPLEX ARTICULAR FRACTURE; C1-METAPHYSEAL SIMPLE; C2-METAPHYSEAL MULTIFRAGMENTARY;C3-ARTICULAR MULTIFRAGMENTARY

7. GUSTILO ANDERSON CLASSIFICATION

   TYPE I – WOUND <1CM LONG. NO EVEIDENCE OF DEEP CONTAMINATION.

   TYPE II – WOUND > 1CM LONG, NO ECXTENSIVE SOFT TISSUE DAMAGE

   TYPE III A – LARGE WOUND, GOOD SOFT TISSUE COVERAGE

   TYPE III B – LARGE WOUND EXPOSED BONE FRAGMENTS, EXTENSIVE STRIPPING OF PERIOSTEUM

   TYPE III C – LARGE WOUND WITH MAJOR ARTERIAL INJURY

8. PRE-OPERATIVE SHORTENING 1- 1CM ; 2- 2CM; 3- 3CM; 4- 4CM; 5- 5CM
9. COMORBIDITIES 1-NIL; 2-ASTHMA; 3-DM; 4-HT

10. DIAGNOSIS INU-INFECTED NON-UNION
11. KNEE RANGE OF MOVEMENTS
12. ANKLE DORSIFLEXION(DF)
13. ANKLE PLANTARFLEXION(PF)
14. DEFORMITY-DEF
15. INFECTION; 0-NO GROWTH; 1-E.COLI; 2-KLEBSIELLA; 3-STAPH AUREUS; 4-ENTEROCOCCUS; 5-MRSA
16. NO OF PREVIOUS SURGERY: 1, 2, 3.
17. TYPE OF NON-UNION: DROR PALEY CLASSIFICATION
18. ADDED SURGERY: 0-NO; 1-SSG.
19. CORTICOTOMY
20. UNIFOCAL/BIFOCAL – 0-NIL;1-UNI;2-BIFOCAL
21. FRAME
22. CONSOLIDATION
23. UNION TIME IN MONTHS(M)
24. TOTAL DURATION IN MONTHS(M)
25. SMOKING: 1-YES; 2-NO.
26. REFRACTURE - 1 YES; 2 NO.
27. REVERSE CONSOLIDATION
28. PIN SITE INFECTION: 1-YES;2-NO
29. UNITED: 1-YES;2-NO

30. INFECTION: 1-PRESENT;2-ABSENT
31. DEFORMITY: 1-<7 DEGREES; 2->7DEGREES
32. LLD-LIMB LENGTH DISCREPANCY: 1->2.5CM; 2-<2.5CM
33. BONE RESULT: 1-EXCELLENT; 2-GOOD; 3-FAIR; 4-POOR
34. ACTIVITY: 1-INACTIVITY; 2-ACTIVE
35. LIMP: 1-NOTICEABLE; 2-NON-NOTICEABLE
36. KNEE ROM
37. ANKLE DORSIFLEXION
38. ANKLE PLANTARFLEXION
39. RSD-REFLEX SYMPATHETIC DYSTROPHY 1-YES; 2-NO
40. PAIN: 1-PRESENT; 2-ABSENT
41. FUNCTIONAL RESULTS: 1-EXCELLENT; 2-GOOD; 3-FAIR; 4-POOR

# PATIENT EVALUATION PROFORMA

Name :

Age / Sex :

IP number :

Address :

Contact Number :

Date of Admission :

Date of Surgery :

Date of Discharge :

Occupation :

Education :

Socioeconomic Status :

**HISTORY:**

1. Mode of injury : Road traffic accident / Pedestrian struck injury / Fall from height

2. Presenting complaints :
    a. Pain – site / duration
    b. Swelling – site / extent
    c. Deformity
    d. Disturbances in function of knee and ankle – movements / sensations
    e. Other associated injuries – head injury / limb injuries / spine injuries

3. Comorbid illnesses :

| | | | | | |
|---|---|---|---|---|---|
| Diabetes mellitus | | Hypertension | | Coronary heart disease | |
| Renal disorder | | Seizures /Neurological disorder | | Hepatic disorder | |
| Dyslipidaemia | | Endocrine disorder | | Tuberculosis | |
| Bronchial Asthma | | Chronic Obstructive lung diseases | | Neoplastic disorders | |

4. Drug history : Steroids / Disease modifying anti-rheumatoid drugs / Immunosuppressants

**PAST HISTORY:**

- Any similar injuries

- Previous surgeries or hospitalisations
- Any major illnesses

**PERSONAL HISTORY:**

| | |
|---|---|
| Diet | Vegetarian / Mixed |
| Marital Status | Married / Single |
| Bowel and Bladder habits | Regular / Altered |
| Habits | Smoking / Alcohol / Tobacco / Drug Addictions / Others |

**OBSTETRIC & GYNAECOLOGY HISTORY:**

**TREATMENT HISTORY:**

**FAMILY HISTORY:**

**CLINICAL EXAMINATION:**

**GENERAL EXAMINATION:**

- ☞ Appearance :
- ☞ Built :
- ☞ Pallor :
- ☞ Icterus :
- ☞ Cyanosis :
- ☞ Clubbing :
- ☞ Pedal Edema :
- ☞ Lymphadenopathy :

**VITALS:**

1. Pulse :
2. BP :
3. Respiratory rate :
4. Temperature :

**SYSTEMIC EXAMINATION:**

- ☞ Cardiovascular system :
- ☞ Respiratory system :
- ☞ Abdomen :
- ☞ Central Nervous System :

**REGIONAL EXAMINATION**

RIGHT /LEFT LEG

**OTHER INJURIES**

**X – RAY FINDINGS**

**3D CT** RIGHT/LEFT KNEE JOINT WITH PROXIMAL TIBIA (If needed)

**INVESTIGATIONS:**

| | | | | | |
|---|---|---|---|---|---|
| Hb% | | TC | | DC | P L B E M |
| ESR | | BT/CT | | RBS | |
| UREA | | S.CREATININE | | ELECTROLYTES | $Na^+$ $K^+$ |
| HBsAg | | HIV | | VDRL | |
| CXR | | ECG | | URINE ROUTINE ALBUMIN SUGAR DEPOSITS | |
| Blood G & T | | | | | |

**FINAL DIAGNOSIS:**
**INITIAL TREATMENT GIVEN:**

**PLANNED SURGERY :**

**PROCEDURE NOTES**

**POST OP PERIOD:**

| **FOLLOW UP (After discharge)** | **CLINICAL FINDINGS** | **X–RAY FINDINGS** | **ADVICE** |
|---|---|---|---|
| **FIRST WEEK** | | | |
| **SECOND WEEK** | | | |
| **FIRST MONTH** | | | |
| **SECOND MONTH** | | | |
| **THIRD MONTH** | | | |
| **SIXTH MONTH** | | | |
| **NINTH MONTH** | | | |
| **ONE YEAR** | | | |
| **ONE YEAR SIX MONTHS** | | | |
| **TWO YEAR** | | | |

**OUTCOME:**

## நோயாளிஒப்புதல்படிவம்

ஆராய்ச்சியாளரின் நேர் கூறி தொற்று ஏற்பட் கூடாத எல் வழங்கு முறிபோத இல்லாமை வளம் பொருத்தம் அறுவசிச்சையின் பயனாகள அறிய ஆட்டு

ஆராயசியாளர் அலர்ப்பங்கம்மருத்துக்கல்லூரிமருத்துவமனை

நோயாளியின்பெயர்: நோயாளியினபெயர்:

மதிப்புமை:

நோயாளிதகவல்பெறுவதற்கான : ✔ செய்யவும்

1. மேற்குறியிட்டஆராய்சியினதோக்கங்களுடனும்பயனபாடுகளுடனும்நடைமுறை
2. மேலுமிந்தஆராய்சிக்குவதுமிருபத்தினபோது வேண்டியவரை
3. ஆராய்சியாளரோ, ஆராய்சிகுழுவினரோ ஆராய்சியாளரின் ஆராய்சிபோதிய முழுவதெளிவாபதாலும் நான்கொண்டோ
4. இந்தஆராய்சிஆராய்சமுடிவுகளை எனதுதனிப்பட்டவிபரங்கள்
5. இந்தஆராய்சித்திற்தேவையான எனது
6. இந்தஆராய்சியாளருடன் எனது

நோயாளிகையொப்பம் / பெருவிரலடையாளம் ஆராய்சியாளரின்கையொப்பம்

இடம் தேதி